# 7 *Evidence for the contrastive hierarchy in phonology*

## 7.1 Introduction

In section 3.7 I sketched the outlines of a theory of phonology that was distilled from the leading ideas discussed in chapter 3. This theory adopts the Contrastivist Hypothesis, which holds that phonology computes only contrastive features. It determines what the contrastive features in a language are by applying the SDA to a contrastive feature hierarchy for that language. In keeping with the Contrastivist Hypothesis, phonological activity serves as the chief heuristic for determining what the feature hierarchy is for a given language.

Though the ingredients for such a theory were in place by the 1930s, phonological theory did not develop in this direction; why it did not was the subject of chapters 4–6. These chapters show that the theory of section 3.7 has never properly been put to the test. In this chapter I argue that these ideas remain viable and indispensable to an explanatory theory of phonology.

Of course, any contemporary effort to implement such a theory must take account of advances in phonology since the 1930s. For example, the diagnostic given in (38d) of chapter 3, that a contrastive feature must be present in all the allophones of a phoneme, is not consistent with the generative phonological conception that phonology is relatively *abstract* with respect to phonetics. In keeping with Chomsky and Halle's arguments against taxonomic phonemics, it is unlikely that we can put limits on the degree to which a segment may be modified in the course of a derivation. But the principle in (38d) may still have some heuristic value: the fact that all the allophones of a phoneme share a certain feature could lead us to suspect that this feature is contrastive, in the default case, in the absence of stronger conflicting evidence.

An example is the Russian phoneme /i/, which has allophones that vary in backness but share the property of being [−round]. In the absence of conflicting evidence, we would suppose, with Jakobson (1962b [1931]), that [−round] is contrastive for /i/ and [back] is redundant (see chapter 1, section 1).

However, we will see in section 8.3 that there is more compelling evidence from phonological activity that /i/ is contrastively [−back]; the [+back] allophone is the result of spreading of [+back] from a preceding consonant.

In this chapter I will provide further evidence for the Contrastivist Hypothesis and the contrastive hierarchy in the framework of a contemporary theory that has the main properties of the one sketched in chapter 3, section 7. The cases surveyed below draw mainly on research carried out at the University of Toronto since the mid-1990s in the context of the project on ‘Markedness and the Contrastive Hierarchy in Phonology’ (Dresher and Rice 2007). This approach to phonology has come to be known as Modified Contrastive Specification (MCS).

In the following section I will sketch some of the key characteristics of MCS, pointing to similarities with and differences from other contemporary approaches. Particular topics are the relationship between contrast and markedness (section 7.2.1), variation in the feature hierarchy (section 7.2.2) and the relationship between phonology and phonetics (section 7.2.3).

Section 7.3 shows that feature hierarchies, considered apart from any theory of contrast, are widespread in phonological theory and practice; therefore, the incorporation of contrastive hierarchies into MCS does not create a descriptive or explanatory burden not shared by other theories of phonology. Subsequent sections take up, in turn, vowel harmony (section 7.4), metaphony (section 7.5), consonant co-occurrence restrictions (section 7.6), loanword adaptation (section 7.7) and language acquisition (section 7.8). I will argue that evidence in all these domains supports the MCS approach. Finally, section 7.9 considers whether the Contrastivist Hypothesis is too strong, and discusses some possible refinements.

## 7.2 Modified Contrastive Specification

MCS began with a focus on complexity in phonology (Avery and Rice 1989; Dresher and Rice 1993; Dresher, Piggott and Rice 1994; Dresher and van der Hulst 1998), and evolved to concentrate on markedness and contrast.[1] In this model, complexity in representations is driven by both contrast and markedness. Assuming that each feature has a marked and unmarked value, MCS posits that

1 Some of the material in this section is adapted from a description of MCS written jointly with Keren Rice.

only marked features count toward complexity; thus, segments with fewer marked features are less complex than those with more marked features.[2]

### *7.2.1 Contrast and markedness*

MCS proposes that contrasts are determined by the SDA operating on a hierarchy of features. Since a more marked representation is permitted only if needed to establish a contrast with a less marked one, the theory of MCS leads us to expect a relation between the amount of segmental markedness a system allows and the number and nature of contrasts it has.

The assumption that markedness is related to contrast is inconsistent with the view that markedness scales are universally fixed (Chomsky and Halle *SPE*; Cairns 1969; Kean 1980; Beckman 1997; Lombardi 2002; Prince and Smolensky 2004; de Lacy 2006; see Rice 2007 for discussion). For example, in a vowel inventory with a front and back vowel, say /i, a, u/, either /i/ or /u/ may pattern as marked with respect to phonological activity, because only one contrast is required to distinguish front unrounded from back rounded vowels (say, [labial] or [coronal], but not both).[3] However, if a central vowel such as /ɨ/ or /ə/ is added, the prediction is that both the front and back vowels will pattern as marked with respect to the central vowel. This follows from the assumption that there is no feature [central], with the consequence that now both [labial] and [coronal] are required to distinguish the vowels from each other. It thus follows that the central vowel must be unmarked, a prediction that is empirically supported (see Rose 1993; Walker 1993; and Rice 2007).[4]

An illustration of this principle can be found in developments in the Yupik and Inuit/Inupiaq dialects of Eskimo-Aleut.[5] These dialects descend from a proto-language that had four vowels, as shown in (1).

2 There are many conceptions of markedness in the contemporary literature. As with contrast, the MCS notion of markedness also has roots in the work of Trubetzkoy, particularly in his distinction between *logical* (structural) and *natural* (phonetic) markedness (cf. Rice 2007). In MCS the emphasis is on logical markedness, which is relative to a particular inventory.

3 I will continue the practice of the previous chapters of using the feature names used in my sources. In MCS we have been using vowel features [coronal] and [labial], and sometimes [peripheral] (see Rice 1994, 2002). However, I take no stand here on whether vowel features are identical to consonant features or distinct from them (see Clements and Hume 1995 and Halle, Vaux and Wolfe 2000 for different views). For the purposes of this book, [coronal] is interchangeable with [front], and [labial] with [round].

4 Dispersion Theory (Flemming 2002, Padgett 2003a, b) also takes a systemic view of markedness.

5 ‘Inuit’ is the name used in Canada for this language family, ‘Inupiaq’ is the name used in Alaska. I would like to thank Richard Compton for discussion of this example.

(1) Proto-Eskimo vowels (Fortescue, Jacobson and Kaplan 1994)

| | | |
|---|---|---|
| i | | u |
| | ə | |
| | a | |

Phonological patterning in Inuit dialects suggests that the contrastive features for this inventory are as given in (2) (Compton and Dresher 2008). Because of the symmetry of the vowel system, the ordering of the features is not crucial in this inventory: the division lines in (2) depict an ordering in which [low] is the first feature. We also suppose that [labial] is ordered above [coronal], for reasons that will become clear shortly. Only marked feature values are shown.

(2) Contrastive features for dialects distinguishing four vowels

| | | |
|---|---|---|
| [coronal] | | [labial] |
| i | | u |
| | ə | |
| | a | [low] |

Yupik dialects and the Diomede subdialect of Bering Strait Inupiaq retain this four-vowel system. However, schwa does not have the same status as the other vowels: according to Kaplan (1990: 147), it ‘cannot occur long or in a cluster with another vowel’. The latter phenomenon is characteristic of unmarked elements: they tend to be targets of phonological processes, and they are not triggers (Rice 2007). In this case, schwa assimilates to neighbouring vowels, and does not cause assimilation in other vowels.

The influence of contrast and markedness can be seen in Inuit dialects that have palatalization of consonants. On the assumption that palatalization of a consonant by a vowel is triggered by a contrastive [coronal] feature, /i/ in (1) could trigger palatalization, but /ə/ could not.[6] In most Inuit dialects the vowel represented as */ə/ has merged at the surface with */i/. Some contemporary dialects, however, distinguish between two kinds of *i*: ‘strong *i*’, which descends from */i/, and ‘weak *i*’, which comes from */ə/. In North Alaskan Inupiaq, strong *i* triggers palatalization of alveolar consonants, but weak *i* does not. Some examples from the Barrow dialect are given in (3). The suffixes in (a) have initial alveolar consonants following a stem ending in *u*; the suffixes in (b) show palatalization of the suffix-initial consonant following strong *i*; and the forms in (c) show that palatalization does not occur after weak *i*. Note that the palatalization of /t/ results in *s* here and in most Inuit dialects.

6 How palatalization works is the subject of some debate; see Kenstowicz (1994) and T. A. Hall (2007) for overviews and references. All that is important here is that /i/ bears some contrastive feature that triggers palatalization.

(3) Barrow Inupiaq palatalization after strong *i* (Kaplan 1981: 82)

| | *Stem* | *Gloss* | *'and a N'* | *'N plural'* | *'like a N'* |
|---|---|---|---|---|---|
| a. | iglu | 'house' | iglulu | iglunik | iglutun |
| b. | iki | 'wound' | ikiʎu | ikiɲik | ikisun |
| c. | ini | 'place' | inilu | ininik | initun |

Further, weak *i* undergoes a variety of assimilation and deletion processes that do not affect strong *i* or the other vowels *u* and *a*. For example, weak *i* changes to *a* before another vowel (4a), but strong *i* does not (4b). According to Kaplan (1981), weak *i* also alternates with *u* in some restricted contexts and with zero (i.e., it syncopates) in other contexts.

(4) Barrow Inupiaq weak and strong *i* before a vowel (Kaplan 1981: 119)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| a. | aŋuti | + | -u- | + | -tuq | → | aŋutauruq |
| | 'man' | | COPULA | | 3SG. | | 'it is a man' |
| b. | iki | + | -u- | + | -tuq | → | ikiuruq |
| | 'wound' | | COPULA | | 3SG. | | 'it is a wound' |

Following Underhill (1976) and Kaplan (1981), I suppose that dialects that distinguish between strong and weak *i* retain four underlying vowels, as in the proto-language, with the same contrastive features as in (2). Though this analysis is 'abstract' with respect to the surface phonetics, the analysis is committed to specifying the fourth vowel phoneme only as not low, not labial and not coronal (i.e., some non-low unrounded central vowel).[7]

These contrastive marked values account for the fact that /i/ can trigger palatalization, as it has a relevant contrastive feature. The fourth vowel is the least marked, literally, and therefore cannot trigger palatalization, and is more susceptible to receive features from the context.

In over half of the Inuit dialects from Alaska to Labrador there is no longer any distinction between the two kinds of *i*: in all these dialects, etymological */i/ and etymological */ə/ have merged completely as *i*.[8] It is a striking fact that none of these dialects has consonant palatalization triggered by /i/ (Compton and Dresher 2008). Compton and Dresher (2008) posit that [low] and [labial] are ordered ahead of [coronal] in the contrastive hierarchy of the Inuit language family; with only three vowels in the inventory, only the former two features can be contrastive, as shown in (5). Lacking a contrastive feature, /i/ can no longer trigger palatalization. This analysis thus explains a conspicuous gap in the typology of Inuit dialects: there are palatalizing dialects with four underlying

7 See Archangeli and Pulleyblank (1994: 73–84) for an analysis that is similar in spirit, but proceeding from different theoretical assumptions.

8 See Dorais (2003) for a survey.

vowels, and non-palatalizing dialects with three underlying vowels, but no palatalizing dialects with three underlying vowels.

(5) Contrastive features for dialects distinguishing three vowels

| | [labial] |
|---|---|
| i | u |
| a | [low] |

Many other examples of contrast-driven markedness asymmetries have been adduced. Studies in the general MCS framework include, among others: Avery and Rice (1989), Rice and Avery (1993), Avery (1996), Rice (1996) and Radišić (2007) on asymmetries in the markedness of consonants; and Rice and Avery (1993), Rose (1993), Causley (1999), Frigeni (2003, 2009), Rice (2002, 2003), D'Arcy (2003a) and Rohany Rahbar (2006, 2008) on vowel systems.[9]

### *7.2.2 Variation in the feature hierarchy*

Analyses of many languages in MCS suggest a certain amount of variation in the feature hierarchy. We observed such variation in chapters 3 and 4, and more examples will be presented in the course of this and the following chapter. To cite but one example here, we have seen immediately above that Inuit vowel systems have the order [labial] > [coronal]. Many languages show a similar pattern of /i/ being unmarked in relation to /u/. But this pattern is not universal; we will see in section 7.4 that Manchu-Tungus and Mongolian vowel systems have [coronal] > [labial].

Studies in MCS that demonstrate variability in the feature hierarchy include work on vowel systems (Aka: Balcaen 1998; Japanese: Hirayama 2003; Manchu-Tungus: Zhang 1996; Mandarin: Zhou 1999; Miogliola: Ghini 2001a, b; Persian: Rohany Rahbar 2006, 2008; Québécois French: Mercado 2002; Sumerian: E. J. M. Smith 2007; Yokuts: D'Arcy 2003a) and consonant systems (Czech: D. C. Hall 1998, 2007, 2008; Inuktitut: Compton 2008; Japanese: Rice 1997, 2005; Latvian: Vilks 2002; Mandarin: Wu 1994; Old English: Moulton 2003; Vietnamese: Pham 1997, 1998). Variations are observed in the feature hierarchy for place of articulation (Rice 1996), stop vs continuant consonants, and height vs place for vowels. Avery (1996) found evidence for

9 For a concise review of this issue, see Rice (2007). Not all activity-based diagnostics that have been proposed in the literature are equally reliable. See Rice (2003, 2007, forthcoming) for further discussion of markedness. Rice argues that asymmetries in assimilation provide the most revealing test of markedness. If we found, for example, that /t/ assimilates to /k/ but /k/ does not assimilate to /t/, that would be evidence that /k/ is marked relative to /t/.

variation in voicing systems. In tone systems, high tones are unmarked in some languages and low tones in others (Rice 2003; Rice and Hargus 2005).

The limits of this variation remain to be determined. It may be, for example, that some of the cross-linguistic variation is related to differences in the structure of inventories (Béjar 1998; Casali 2003; Herd 2005). That there are limits is suggested by the fact that certain feature orders produce unnatural-looking inventories, as shown in section 7.3.

### *7.2.3 Phonology and phonetics*

A consequence of the MCS approach is that phonology is necessarily underspecified with respect to phonetics: the number and nature of contrasts that a segment enters into influence, but do not determine, its phonetic realization. Therefore, the contrastive specifications assigned by the phonological component must be supplemented by further principles to derive the detailed phonetic specification of a speech sound.

In the four-vowel system in (1), for example, the vowel /a/ is phonologically specified as being contrastively [low]. The fact that it is realized phonetically as [a] and not [æ] or [ɑ] or [ɒ] is due to other principles. The vowel designated as /i/ in (2) is fundamentally different from the /i/ in (5). The former is contrastively [coronal]; this [coronal] feature is also part of its phonetic realization as [i]. The /i/ in (5) does not have a contrastive [coronal] feature: its contrastive characterization is purely negative, as Trubetzkoy would put it. It is not [low] and it is not [labial]. Phonologically, then, the vowel in (2) that most closely corresponds to /i/ in (5) is /ə/, not /i/. Why, then, does this vowel surface as [i] and not as [ə] or [ɨ]?

#### 7.2.3.1 Phonetic enhancement

Stevens, Keyser and Kawasaki (1986) and Stevens and Keyser (1989) propose that phonological contrasts can be *enhanced* by phonetic specification of non-contrastive features. These enhancements serve either to increase the perceptual salience of the contrastive feature, or to increase the perceptual salience of a contrast. The notion of enhancement was adopted by MCS (Avery and Rice 1989; Rice 1993, 1996; Wu 1994; Dyck 1995; Causley 1999). In the three-vowel system in (5), the contrastively non-low vowels are enhanced by the feature [high], the contrastively [labial] vowel is enhanced by [back], and the non-labial non-low vowel is enhanced by the place feature [coronal].

Enhancement thus also partly accounts for why certain inventories are more common than others; why, for example, /i, a, u/ is more common than /ə, a, u/ or /ɨ, a, u/ (on this, see, further, section 8.3).

#### 7.2.3.2 Phonetics in phonology versus phonological minimalism

MCS was developed in the context of works that argue that the phonology is underspecified with respect to phonetics; in addition to the papers on enhancement mentioned above, these include Keating (1988), Cohn (1993) and Lahiri and Reetz (2002). Kingston and Diehl (1994) also argue that an elaborate phonetic component is required to complement the phonology.

These were followed by proposals that aim to diminish or eliminate the distance between phonetics and phonology by arguing that noncontrastive phonetic features play a role in phonology (e.g., Kirchner 1997, 1998; Steriade 1997; Boersma 1998; Flemming 2001, 2002), and that much that goes on in phonology is sensitive to detailed phonetic information (Pierrehumbert, Beckman and Ladd 2000; Hayes, Kirchner and Steriade 2004). It should be emphasized that the Contrastivist Hypothesis does not require lexical representations to be free of redundancy. As argued in chapter 2, the aim of the SDA is not to eliminate logical redundancy, but to identify contrastive specifications. Nor is anything in the theory based on an assumption that the brain has limited storage capacity. The claim that the phonological component assigns a special role to contrastive specifications is an empirical hypothesis formulated in order to account for phonological patterning. It is not a question of what memories may be stored in the brain, but of how the phonology is organized.

Reacting to the proliferation of phonetic detail in recent approaches to phonology, some phonologists have been exploring minimalist theories of phonological representation (Hyman 2001, 2002, 2003; Morén 2003, 2006). Clements (2001, 2003, 2009) has argued that feature economy plays a role in accounting for phonological inventories (see D. C. Hall 2007 for discussion). Avery and Idsardi (2001) argue for representational economy and underspecification drawing on evidence from laryngeal systems. Versions of phonological minimalism can be found in other phonological traditions as well, such as Dependency Phonology (J. M. Anderson and Ewen 1987; J. M. Anderson 2005; Carr, Durand and Ewen 2005) and Radical CV Phonology (van der Hulst 1995, 1996, 2005).

## 7.3 Ubiquitous feature hierarchies

The theory of the contrastive feature hierarchy makes two empirical claims. The first claim is that distinctive features in each language are organized into a hierarchy. The second claim is that this hierarchy determines which feature values are contrastive in a given language. In this section I will focus on the first claim and argue that feature hierarchies are widespread in the practice, and in many cases also the theory, of phonology. So ubiquitous are they that it is impossible to avoid considerations of feature ordering in almost any phonological analysis. This should not be surprising; as Halle (1970) remarks, 'Any structure of any kind of complexity presupposes some form of hierarchy.'

### *7.3.1 Feature hierarchies in phonological theory*

The ordering of features into hierarchies is remarkably pervasive in phonology, even where it is not acknowledged explicitly, and even where one might not be aware of it. I have shown that hierarchies, often implicit, were central to structuralist phonology. In generative phonology, we have seen that feature hierarchies are embedded into markedness theory, underspecification theory and feature geometry. Even theories that have not adopted some version of the Contrastivist Hypothesis have required feature hierarchies.

Feature hierarchies are pervasive in Optimality Theory, in the ranking of faithfulness constraints. For example, the tableau in (6) represents a portion of the OT grammar proposed by Baković (2000) for Nez Perce, which will be discussed in section 7.4.4. In this grammar it is more important to preserve underlying values of [low] than of [back]; similarly, [back] is ranked above [ATR].[10]

(6) OT grammar with a feature hierarchy: [low] > [back] > [ATR]

| /–lo, –bk, –ATR/ = ɛ | IDENT [lo] | *[–bk, –ATR] | IDENT [bk] | *[–lo, –ATR] | IDENT [ATR] |
|---|---|---|---|---|---|
| a. [+lo, –bk, +ATR] = æ | *! | | | | * |
| b. [–lo, –bk, –ATR] = ɛ | | *! | | * | |
| c. [–lo, +bk, +ATR] = u | | | *! | | * |
| d. ☞ [–lo, –bk, +ATR] = i | | | | | * |

10 Baković uses the faithfulness constraint IDENT where I have used MAX. Though there are technical differences between the two that have empirical consequences in certain situations, for our purposes we can regard them as interchangeable: in the type of case discussed here, both require that an underlying specification be preserved.

In this example, an input segment /−low, −back, −ATR/ (say, the vowel /ɛ/) surfaces as [i]. Because of the highly ranked constraint IDENT [low], an input vowel must retain its feature [−low] (hence candidate (a) is excluded); the 'faithful' output [ɛ] is excluded because there is a constraint against being [−back] and [−ATR] at the same time; and candidate (c) does not preserve the underlying [−back] feature, violating IDENT [back]; hence, all these candidates lose to (d).[11] The point is that any ranking of faithfulness constraints implies a feature ordering. Thus, the question of whether and how features are ordered in a grammar is independent of the Contrastivist Hypothesis.

### *7.3.2 Implicit feature hierarchies in practice*

Feature hierarchies are often implicit in at least a partial way in the descriptive practice of phonologists. Consider, for example, the way segment inventories are presented in charts in descriptive grammars. Compare the inventory tables of Siglitun (Dorais 2003: 62),[12] an Inuit (Eskimo-Aleut) language spoken in the Canadian Arctic, and Kolokuma Ị̣jọ̣ (Williamson 1965),[13] an Ijoid (Niger-Congo) language spoken in Nigeria, given in (7) and (8), respectively. I present them as they are given in the sources (with some changes to the phonetic symbols but not to the arrangement).

(7) Siglitun consonants (Dorais 2003: 62)

| | Bilabial | Apical | | Velar | Uvular |
|---|---|---|---|---|---|
| Stops | p | t | | k | q |
| Voiced fricatives | v | l | j | ɣ | ʀ |
| Voiceless fricatives | | ɬ | s | | |
| Nasals | m | n | | ŋ | |

11 For the sake of concision I have omitted reference to the feature [high] from this example, and the constraints that rule out [e] in Nez Perce.

12 I have simplified Dorais's *j/dj* and *s/ch* to *j* and *s*, respectively. As he makes clear, these are variants of single phonemes.

13 Williamson notes that Back = palatal, velar or glottal, Vl. = voiceless, and Vd. = voiced. She mentions that some speakers have a marginal phoneme /ɣ/, but she omits it from the table. I have added it because it appears to be no less marginal than /h/, which is included.

(8) Consonant phonemes of Kolokuma Ịjọ (Williamson 1965)

| | Plosive | | Continuant | | | | |
|---|---|---|---|---|---|---|---|
| | | | Fricative | | Sonorant | | |
| | Vl. | Vd. | Vl. | Vd. | Non-lateral | | Lateral |
| | | | | | Oral | Nasal | |
| Labial | p | b | f | v | w | m | |
| Alveolar | t | d | s | z | r | n | l |
| Back | k | g | (h) | (ɣ) | j | ŋ | |
| Labio-velar | kp | gb | | | | | |

Note in particular the different placements of /l/ and /j/ in these charts. The Siglitun chart is not as overtly hierarchical as the one for Ịjọ, but it is clear that the feature which characterizes /l/ and /ɬ/ (presumably [lateral]) has very narrow scope, confined to making distinctions among apicals, whereas [nasal] is higher in the hierarchy. Thus, in the Siglitun chart /l/ and /j/ are 'partners', as are /ɬ/ and /s/. The non-nasal sonorants are not set apart in Siglitun, suggesting that the feature [sonorant] is lower in the hierarchy than in Ịjọ.

The chart for Ịjọ expresses a hierarchy in which the feature [continuant] has wider scope than [sonorant] and [voiced], and [lateral] has wider scope than [nasal]. Now /j/ and /ŋ/ are 'partners', and /l/ stands apart. The Ịjọ chart groups all post-alveolar consonants, including /j/, together under the general place 'back', whereas the Siglitun chart distinguishes between velar and uvular places, and groups /j/ with the apicals.

These sorts of examples can be multiplied indefinitely. Descriptive phonologists display phoneme inventories in ways that illuminate their phonological patterning, and these patterns attest to different hierarchical relations among features. This is not to say that any feature hierarchy is equally likely, or even permitted. It is possible to create rather unnatural-looking phoneme inventories by ordering the features in unusual ways. For example, the chart in (9) is wrong as a description of the Siglitun inventory, and probably wrong for any language with a comparable set of consonant phonemes. What is unusual are the relative scopes of place features and manner features. Such examples show that there are limits to the extent that the feature hierarchy can vary cross-linguistically, though it is not clear what these limits are.

(9) Siglitun consonants: unusual feature hierarchy

| | Labial | Coronal | Velar | Uvular |
|---|---|---|---|---|
| Oral stops | p | t | k | q |
| Nasal stops | m | n | ŋ | |
| Fricatives | v | ɣ | | ʁ |
| Stridents | | s | | |
| Voiced laterals | | l | | |
| Voiceless laterals | | ɬ | | |
| Glides | | j | | |

### *7.3.3 Feature scope ambiguities*

Finally, it is impossible to escape having to make decisions about the scope of a feature. Such decisions are not always thought of as involving feature ordering, but they do, because the relative scope of features can be expressed in terms of ordering. Deciding on the scope of a feature is particularly important when there are asymmetries in a phoneme inventory.

Eastern and Valencian Catalan, for example, have seven stressed vowels /i, e, ɛ, a, ɔ, o, u/. Analysts agree that /i, u/ are high and /a/ is low; assuming that the main contrast between the mid vowels is [ATR], it must be decided whether this feature is confined to the mid vowels, or if it extends to include the high and low vowels as well.[14] One can find both kinds of analysis: Crosswhite (2001) assumes that [ATR] is confined to the mid vowels (10a), whereas Walker (2005) and Lloret (2008) assign values of [ATR] to all the vowels (10b).

(10) Two analyses of Catalan vowels

a. Eastern Catalan (Crosswhite 2001)

| | | [+front] | | [–front] |
|---|---|---|---|---|
| [+high] | | i | | u |
| | [+ATR] | e | | o |
| | [–ATR] | ɛ | | ɔ |
| [+low] | | | a | |

14 Not all authors use a binary [ATR] feature to characterize this system. Jiménez (1998) uses [RTR] instead of [−ATR]. Wheeler (2005: 56) characterizes /e, o/ as [+close] and /ɛ, ɔ/ as [−close]. Whatever feature is chosen, questions of scope arise (unless it is limited by definition to certain types of phonemes: if, for example, [close] is defined to be applicable only to mid vowels).

b. Valencian Catalan (Walker 2005; Lloret 2008)

| | | | | |
|---|---|---|---|---|
| | | [front] | | [back] |
| [+ATR] | [high] | i | | u |
| | | e | | o |
| [–ATR] | | ɛ | | ɔ |
| | [low] | | a | |

In the Catalan case we may simply be dealing with one system whose analysis is in dispute; but there are cases where there is evidence that different dialects with similar-looking inventories actually differ in their feature ordering, and hence in the relative scopes of contrastive features. We saw a number of such examples in chapter 3; here I will present one more.

Both Anywa (Reh 1996) and Luo (Tucker 1994), related Nilotic languages, have a dental/alveolar contrast in the coronal stops; in both languages, the alveolar nasal /n/ has no dental nasal partner. Should /n/ be considered contrastively alveolar (in contrast to the coronal dental stops in general), or is it outside the dental/alveolar contrast, being only redundantly alveolar? Mackenzie (2005, 2009) argues that the two languages adopt different solutions to this question: in Anywa /n/ acts as if it is contrastively alveolar (11a), in Luo it acts neutrally with respect to the contrast (11b).[15]

(11) Nilotic dental/alveolar contrast (Mackenzie 2005)

a. Anywa b. Luo

| Dental | Alveolar | | Dental | Alveolar |
|---|---|---|---|---|
| t̪ | t | voiceless stops | t̪ | t |
| d̪ | d | voiced stops | d̪ | d |
| | n | nasals | n | |

### 7.3.4 *Feature hierarchies and phonological patterning*

Given that feature hierarchies have always been a part of phonology and are here to stay, it is worth reflecting on their significance. Notice that in all the

15 See Mackenzie (2005, 2009), for further details and the reasons for adopting this analysis. Mackenzie observes that the two consonantal inventories are not in fact identical: Luo has a set of prenasalized stops that also participate in the dental/alveolar contrast. It is possible that the slightly different compositions of these segmental inventories contribute to an explanation of why the contrastive hierarchies in these languages are different (cf. Béjar 1998 and D. C. Hall 2007: 152–3 for discussion).

examples reviewed in this section, the issue is not the *phonetic* description of the phonemes. I assume that Siglitun and Ịjọ *l*, *j*, etc. are phonetically similar enough for them to be depicted with the same symbols /l/, /j/, and so on. Any further phonetic details that may distinguish them are not in any case provided in the phoneme charts, and it is unlikely that phonetic details are what account for their different placements in the charts. The same is true of the Catalan vowels and Nilotic dental and alveolar consonants. No one disputes that Catalan *i* and *u* are phonetically ATR, or that Nilotic *n* is phonetically alveolar; the question in each case is whether they function *phonologically* as though they are specified for these features. It follows from the Contrastivist Hypothesis that this amounts to asking whether they are *contrastively* specified for the features in question.

### *7.3.5 Feature hierarchies: summary*

I mentioned at the outset of this section that contrastive hierarchy theory claims that features are ordered, and that this ordering determines the contrastive specifications for a language. I argued in chapter 2 and throughout that feature ordering is the best way to determine contrastive specifications. One might think that having to order the features just for purposes of determining contrast is an unacceptable cost, for it imposes on learners and analysts the burden of arriving at the correct feature ordering. What I have tried to show in this section is that this burden exists independently of any particular theory of contrast. Feature ordering in one form or another is a characteristic of all theories of phonology.

In the rest of this chapter I provide further evidence for the second claim of contrastive hierarchy theory and for the Contrastivist Hypothesis: the feature hierarchy is what determines contrastive features, and only contrastive features are active in the phonology.

## 7.4 Vowel harmony

An important diagnostic of phonological activity is the spreading of a feature from a segment bearing that feature to neighbouring segments. In this sense, vowel harmony is a fairly reliable indicator of the presence of an active feature or features. The Contrastivist Hypothesis states that phonologically active features are contrastive; the corollary of this principle in the domain of vowel harmony is that harmony triggers should be contrastive features.[16]

16 The situation is less clear with targets and other non-triggers, such as transparent and opaque segments. There are various reasons why segments may block harmony, not all derived from their contrastive status. Similarly, targets may be restricted for reasons beyond their contrastive

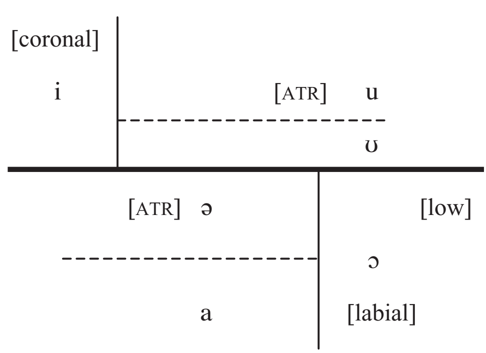
In this section I will review the analysis of Classical Manchu by Zhang (1996), and show that this principle applies in the case of both ATR harmony and labial harmony. The analysis is strikingly supported by diachronic developments in Manchu, showing how changes in the contrastive status of vowels leads to new patterns of phonological activity, as predicted. The analysis of labial harmony is further supported by typological surveys of labial harmony: in all cases, the vowel triggering the harmony can be shown to be contrastive.

To complete this section, I will review an OT analysis of Nez Perce harmony by Baković (2000). Like Classical Manchu, Nez Perce has ATR harmony; however, Baković's analysis appears to suggest that the spreading [ATR] feature is not contrastive. If this analysis were correct it would be a problem for the Contrastivist Hypothesis. Mackenzie (2002) shows, however, that this aspect of the analysis has no empirical support; in her analysis, [ATR] is clearly contrastive.

### *7.4.1 Classical Manchu (Zhang 1996)*

The vowel system of Classical Manchu as analysed by Zhang (1996) was presented in section 6.4.3, where it was used to demonstrate how to convert a feature hierarchy into an OT hierarchy.[17] The vowel system and the proposed contrastive features are shown again in (12). Recall that Zhang (1996) proposes the feature hierarchy: [low] > [coronal] > [labial] > [ATR]. The resulting specifications are shown in (12) in chapter 6, and a corresponding OT feature hierarchy is given in (16) in chapter 6. Here I will focus on the motivation for, and empirical consequences of, this analysis.

(12) Classical Manchu vowel system (Zhang 1996)




status; see van der Hulst and van de Weijer (1995) and Archangeli and Pulleyblank (2007) for surveys. Here I will focus on harmony triggers.

17 The data and analysis of Manchu and related languages in this and the following sections are based on Zhang (1996); see Zhang (1996: 32) for discussion of the transcriptions and phonetic values. See also Zhang and Dresher (1996), Dresher and Zhang (2004), Zhang and Dresher (2004) and Dresher and Zhang (2005) for more details.

The first contrast applies to all the vowels and divides them into a [low] (/a, ə, ɔ/) and non-low (/i, u, ʊ/) set. Splitting the inventory in this manner has the effect of allowing for different contrasts in each set.

The next feature, [coronal] (= [−back]), applies only to /i/. This has a number of important empirical consequences. First, it means that /i/ will receive no further contrastive specifications; notably, it does not receive a specification for [ATR], despite the fact that it is phonetically ATR. Second, because the non-low vowels have already been split from the low vowels, no further features are required to draw a contrast between /i/ on one side and /u/ and /ʊ/ on the other. In particular, these latter vowels have no contrastive specification for [labial] (= [round]), despite the fact that they are phonetically rounded vowels.

No low vowels are eligible to receive a [coronal] specification, so [coronal] has no contrastive effect on the low vowels. Hence, a feature is needed to distinguish between /ɔ/ on one side and /a/ and /ə/ on the other. This contrast is made by the next feature on the list, which is [labial]. The consequence of this is that /ɔ/ is the only contrastively [labial] vowel in the inventory.

The next feature is [ATR]. It distinguishes /u/ from /ʊ/ and /ə/ from /a/. This feature also accounts for the height differences in these pairs of vowels, as [ATR] vowels tend to be higher than their non-ATR counterparts (Archangeli and Pulleyblank 1994). The vowels /i/ and /ɔ/ are not contrastive for this feature, in this ordering.

The evidence for these contrastive specifications is summed up in (13).

(13) Summary of evidence for contrastive specifications of Classical Manchu vowels

a. /i/ lacks contrastive [ATR]: /u/ and /ə/ trigger ATR harmony, but /i/ does not, though /i/ is phonetically [ATR].
b. /u/ and /ʊ/ lack contrastive [labial]: /ɔ/ triggers labial harmony, but /u/ and /ʊ/ do not, though they are phonetically [labial].
c. /i/ is contrastively [coronal]: /i/ triggers palatalization of consonants, suggesting it has some relevant contrastive feature.
d. All vowels are contrastively assigned to one of two height classes: alternations /ə/ ∼ /a/ ∼ /ɔ/ and /u/ ∼ /ʊ/ are limited to a height class. We need one height feature, which we call [low].

A more detailed discussion of the harmony facts follows.

#### 7.4.1.1 ATR harmony

All vowels in a word, apart from /i/, must agree with respect to [ATR], as shown in (14).

(14) ATR harmony in Classical Manchu

a. /ə/ alternates with /a/

| | | | |
|---|---|---|---|
| xəxə | 'woman' | xəxə-ŋgə | 'female' |
| aɢa | 'rain' | aɢa-ŋɢa | 'of rain' |

b. /u/ alternates with /ʊ/

| | | | |
|---|---|---|---|
| xərə- | 'ladle out' | xərə-ku | 'ladle' |
| paqt'a- | 'contain' | paqt'a-qʊ | 'internal organs' |

The alternation between /u/ and /ʊ/ is apparent only after back (velar and uvular) consonants (which also alternate, depending on the following vowel). In other contexts, /u/ and /ʊ/ merge at the surface as [u], except in a few sporadic examples. Zhang (1996) assumes that this is a late phonetic rule, since it does not affect the behaviour of /ʊ/ with respect to ATR harmony, as shown in (15).

(15) Merger of /ʊ/ to [u] except after back consonants

a. Underlying /u/: ATR harmony

| | | | |
|---|---|---|---|
| susə | 'coarse' | susə-tə- | 'make coarsely' |
| xət'u | 'stocky' | xət'u-kən | 'somewhat stocky' |

b. Underlying /ʊ/ not after velar/uvular consonants

| | | | |
|---|---|---|---|
| tulpa | 'careless' | tulpa-ta- | 'act carelessly' |
| tat'ʂ̧un | 'sharp' | tat'ʂ̧u-qan | 'somewhat sharp' |

In each word in (15b) the vowel that surfaces as [u] patterns with non-ATR vowels; compare the forms in (15a). I suppose, following Zhang (1996), that [u] in (15b) derives from /ʊ/, which merges with /u/ as [u] in these environments.

The vowel /i/ is neutral, as shown in (16). It can co-occur in roots with both ATR and non-ATR vowels and with both ATR and non-ATR suffixes (16a, b), and it can itself appear in a suffix following either ATR or non-ATR vowels (16c).

(16) ATR harmony in Classical Manchu: /i/ is neutral

a. /ə/ ∼ /a/ suffix

| | | | |
|---|---|---|---|
| pəki | 'firm' | pəki-lə | 'make firm' |
| paqtʂ̧'in | 'opponent' | paqtʂ̧'i-la- | 'oppose' |

b. /u/ ∼ /ʊ/ suffix

| | | | |
|---|---|---|---|
| sitərə- | 'hobble' | sitərə-sxun | 'hobbled/lame' |
| panjin | 'appearance' | panji-sχʊn | 'having money' |

c. /i/ suffix

| | | | |
|---|---|---|---|
| əmt'ə | 'one each' | əmt'ə-li | 'alone; sole' |
| taχa- | 'follow' | taχa-li | 'the second' |

Surprisingly, when /i/ is in a position to trigger harmony, it occurs only with non-ATR vowels, as in (17).

(17) Stems with only /i/: suffixes with non-ATR vowels

a. /a/ in suffix, not /ə/

| | | | |
|---|---|---|---|
| fili | 'solid' | fili-qan | 'somewhat solid' |
| ili- | 'stand' | ili-χa | 'stood' |

b. /ʊ/ in suffix, not /u/

| | | | |
|---|---|---|---|
| sifi- | 'stick in the hair' | sifi-qʊ | 'hairpin' |
| tʂ'ili- | 'to choke' | tʂ'ili-qʊ | 'choking' |

Despite the fact that it is phonetically an ATR vowel, /i/ does not trigger ATR harmony. This fact is explained if we posit the contrastive specifications in (12), together with the hypothesis that only contrastive values of [ATR] trigger harmony.

The failure of /i/ to trigger ATR harmony is particularly striking given the observation that front high vowels tend to be associated with [ATR], because the gestures required to make a high front vowel are compatible with an advanced tongue root and antagonistic to a retracted tongue root (see Archangeli and Pulleyblank 1994 for discussion and references). While this tendency can account for why /i/ lacks an [RTR] partner, we would expect that /i/, as the ATR vowel par excellence, should trigger ATR harmony if any vowel does. The fact that it does not strengthens the argument that its contrastive status is the key to its neutrality.

### 7.4.1.2 Labial harmony

Another vowel harmony process in Classical Manchu is labial harmony. A suffix vowel /a/ becomes /ɔ/ if preceded by two successive /ɔ/ vowels (18a), but labial harmony is not triggered by a single short or long /ɔ/ (18b).[18] Nor is labial harmony triggered by the high round vowels /u, ʊ/ (18c, d). As with ATR harmony, only a contrastive feature can serve as a harmony trigger. In this case, only /ɔ/, but not /u/ or /ʊ/, has a contrastive [labial] feature.

(18) Labial harmony in Classical Manchu

| | | | | |
|---|---|---|---|---|
| a. | pɔtʂ'ɔ | 'colour' | pɔtʂ'ɔ-ŋɢɔ | 'coloured' |
| | fɔχɔlɔn | 'short' | fɔχɔlɔ-qɔn | 'somewhat short' |
| b. | tɔ- | 'alight (birds)' | tɔ-na- | 'alight in swarm' |
| | tɔɔ- | 'cross (river)' | tɔɔ-na- | 'go to cross' |
| c. | gulu | 'plain' | gulu-kən | 'somewhat plain' |
| | kumun | 'music' | kumu-ŋgə | 'noisy' |
| d. | χʊtun | 'fast' | χʊtu-qan | 'somewhat fast' |
| | tursun | 'form' | tursu-ŋɢa | 'having form' |

18 On this condition, see Zhang and Dresher (1996) and Walker (2001).

### *7.4.2 Evolution of Spoken Manchu and Xibe*

This analysis of Classical Manchu receives additional support from subsequent developments in the modern Manchu languages. The vowels /ə/ and /u/ undergo changes in their contrastive status, leading to new patterns of phonological activity.

We observed that in Classical Manchu the contrast between /u/ and /ʊ/ is neutralized phonetically to [u] in most contexts, with surface [ʊ] surviving only after uvular consonants and sporadically in other contexts in a few words. It is no surprise, therefore, to see this neutralization continue to completion in Spoken Manchu, a modern Manchu language descended from an ancestor similar to Classical Manchu. In Spoken Manchu, /u/ and /ʊ/ have merged completely to [u], and the phoneme /ʊ/ has been completely lost.

In a contrast-driven approach to vowel systems, the loss of a contrast in one part of the system could have wider effects. In the Classical Manchu system, the contrast between /u/ and /ʊ/ involves the feature [ATR], just like the contrast between /ə/ and /a/. As long as the [ATR] contrast between /ə/ and /a/ is paralleled by a similar contrast between /u/ and /ʊ/, it cannot be mistakenly regarded as a height contrast. But with the loss of /ʊ/, the position of [ATR] in the system becomes much more tenuous. For now the entire burden of the [ATR] contrast would fall on the contrast between /ə/ and /a/. That this contrast is based on [ATR], however, is not clear; it could more straightforwardly be attributed to a difference in height. Indeed, the feature [low], which is required independently, can serve to distinguish /ə/ from /a/.

Therefore, without assuming that the phoneme /ə/ changed phonetically, the loss of /ʊ/ could have indirectly led to a change in the phonological status of /ə/, from [low] to non-low. This reclassification, in turn, could have influenced the phonetic realizations of /ə/, because in Spoken Manchu it is definitely a non-low vowel. Zhao (1989) characterizes it as a mid-high back unrounded vowel, with an allophone [ɤ]; according to Ji, Zhao and Bai (1989), [ə] is in free variation with a high back unrounded vowel [ɯ]. It is reasonable to suppose that there is a mutual influence between phonology and phonetics in such cases. The phonetic properties of a vowel obviously influence its phonological representation; but this influence is not simply one way, and the phonological representation can in turn affect the phonetics, by delimiting the space within which the vowel can range (short of neutralization).

The change in status of /ə/ in turn has consequences for the specification of /u/. Recall that in Classical Manchu there is evidence that /i/ is actively [coronal], but there is no evidence that /u/ and /ʊ/ are actively [labial], though they clearly are phonetically round. The elevation of /ə/ to a non-low vowel, joining /i/ and /u/, changes the situation. Assuming, as before, that [coronal] takes precedence, /i/ is again specified [coronal], distinguishing it from /ə/ and /u/. But now we must still distinguish the latter two vowels from each other. The most straightforward distinction is to extend the feature [labial], already in the system for /ɔ/, to /u/, as diagrammed in (19).

(19) Spoken Manchu after loss of /ʊ/

| [coronal] | | [labial] | |
|---|---|---|---|
| i | ə | u | |
| | a | ɔ | [low] |

This analysis thus predicts that the reclassification of /ə/ as a non-low vowel should cause /u/ to become contrastively [labial]. This prediction is borne out in Spoken Manchu, as evidenced by the development of a new phoneme /y/, a front rounded vowel that originated as a positional allophone of /i/ followed by /u/, as well as /u/ followed by /i/ (Zhang 1996). The front feature [coronal] is contributed by /i/, but the round feature [labial] must be contributed by /u/.

Further evidence can be found in the related modern Manchu language Xibe. Unlike Spoken Manchu, Xibe retains a labial harmony rule in which /ə/ alternates with /u/ in suffixes: /u/ occurs if the stem-final vowel is round (20b, c), /ə/ occurs otherwise (20a).

(20) Labial harmony in Xibe (Li and Zhong 1986)

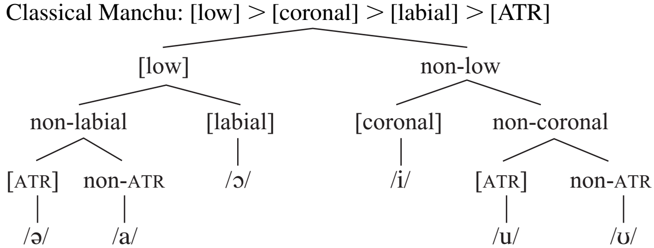
| | *Classical Manchu* | *Xibe* | *Gloss* |
|---|---|---|---|
| a. | gət’ə-xə | gət’ə-xə | ‘awoke’ |
| | ɢɔts̯’i-χa | ɢɔçi-χə- | ‘cherished’ |
| | ərtə-kən | ərtə-kən | ‘somewhat early’ |
| | χants̯i-qan | χantçi-qən | ‘somewhat near’ |
| b. | pɔtɔ-χɔ | pɔtu-χu | ‘thought’ |
| | fɔχɔlɔ-qɔn | fœχulu-qun | ‘somewhat short’ |
| c. | pu-xə | pu-xu | ‘gave’ |
| | ḋus̯uxu-kən | dʑyɕxu-kun | ‘somewhat sour’ |
| | xət’u-kən | xət’u-kun | ‘somewhat stocky’ |
| | farχʊ-qan | farχu-qun | ‘somewhat dark’ |

Recall that in Classical Manchu, labial harmony is restricted to the low vowels, and creates an alternation between /a/ and /ɔ/. In Xibe, noninitial vowels tended to be raised – almost always in suffixes, frequently in stem vowels – so an original sequence of the form /a/ - /a/ would become /a/ - /ə/ or /ə/ - /ə/, and a sequence of the form /ɔ/ - /ɔ/ would become /ɔ/ - /u/ or /u/ - /u/. The labial harmony observed in Xibe is not merely a holdover of Classical Manchu labial harmony, however, for in Xibe harmony is triggered not only by /u/ derived from older /ɔ/ (20b), but also by original /u/ (20c). The fact that /u/ triggers and undergoes labial harmony further supports the hypothesis that it has a [labial] specification in Xibe.

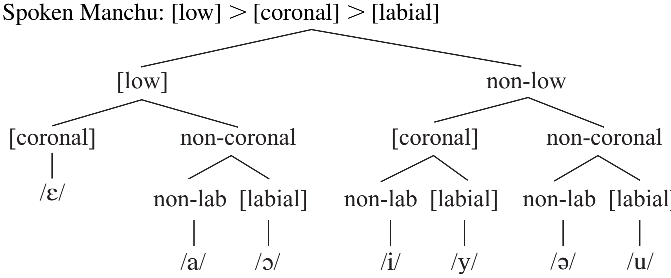
The contrastive hierarchies of the three Manchu languages discussed above are given in (21). Spoken Manchu and Xibe make do with only three contrastive features. They have more vowel phonemes than Classical Manchu because they exploit the possibilities of the three features more fully. For more on the modern Manchu vowel systems and the development of new coronal vowels, see Zhang (1996) and Dresher and Zhang (2005).

(21) Contrastive hierarchies of Manchu languages

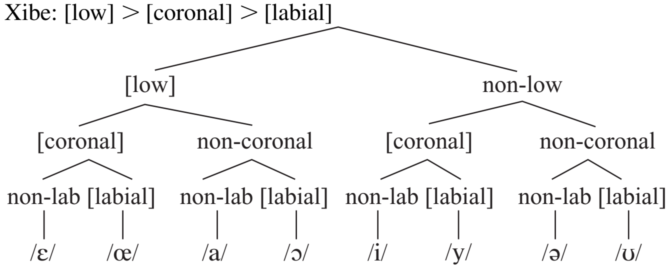
a. Classical Manchu: [low] > [coronal] > [labial] > [ATR]




b. Spoken Manchu: [low] > [coronal] > [labial]




c. Xibe: [low] > [coronal] > [labial]




### *7.4.3 Typological surveys of labial harmony*

Typological surveys of labial harmony in Manchu-Tungus, Mongolian and Turkic languages support the hypothesis that only contrastive features trigger harmony. Zhang (1996: chapter 6) surveys a number of Manchu and Tungusic languages in China and Russia. We have seen that labial harmony in Classical Manchu is limited to the low vowels. On this account, only the low vowel /ɔ/ is contrastively [labial] in this inventory. The same holds for most Manchu-Tungus languages, which have similar vowel inventories. A Tungusic example is Oroqen (Zhang 1996), whose inventory is given in (22); again, only low vowels are triggers and targets of harmony.

(22) Oroqen vowel system (Zhang 1996)

| | | | |
|---|---|---|---|
| [coronal] | | | |
| i ii | | u uu | |
| | | ʊ ʊʊ | |
| e | ə əə | o oo | [low] |
| ɛ | a aa | ɔ ɔɔ | |
| | | [labial] | |

Eastern Mongolian languages have a similar type of labial harmony triggered by and affecting low vowels. An example is Khalkha Mongolian (Svantesson 1985; Kaun 1995), shown in (23).[19] Assuming a similar contrastive hierarchy to that of Manchu-Tungus, again [labial] is contrastive only in the low vowels.

(23) Khalkha Mongolian vowel system (Svantesson 1985; Kaun 1995)

| | | | |
|---|---|---|---|
| [coronal] | | | |
| i | | u | |
| | | ʊ | |
| | ə | o | [low] |
| | a | ɔ | |
| | | [labial] | |

Turkic languages tend to have symmetrical vowel inventories. They are typically analysed with three features: one height feature and two place features. A typical example is Turkish, shown in (24). Assuming three features, [high], [coronal] and [labial] (or their equivalents), the Turkish vowels exhaust the space of possible values. Therefore, all feature values are contrastive; in particular, [labial] is necessarily contrastive in all vowels that are rounded on the surface.

19 See Dresher and Zhang (2005) for further discussion of the phonemic values of the Khalkha Mongolian vowels.

(24) Turkish vowel system

| | [coronal] | | non-coronal | |
|---|---|---|---|---|
| | non-labial | [labial] | non-labial | [labial] |
| [high] | i | y | ɨ | u |
| [low] | e | ø | a | o |

The theory predicts, therefore, that all round vowels could potentially be triggers of labial harmony in such languages. This prediction is correct, though harmony observes limitations that are not due to contrast, but to other factors. That is, having a contrastive feature is a necessary but not sufficient condition for triggering harmony. We find a variety of labial harmony patterns, where high vowels are favoured as triggers and targets, for reasons unrelated to contrast (Korn 1969; Kaun 1995).

In Turkish, for example, harmony triggers can be high or low, but targets are typically limited to high vowels. In Kachin Khakass (Korn 1969), with the same vowel inventory, both triggers and targets of labial harmony must be high, the opposite of the Manchu-Tungus-Eastern Mongolian pattern.

### *7.4.4 Nez Perce*

Nez Perce, a Penutian language of the Pacific Northwest in the United States, is another language that displays ATR harmony, though of a different character than the Manchu type.[20] The differences (directional harmony in Manchu versus a dominant harmony in Nez Perce) do not change our expectation that [ATR] should be a contrastive feature. An analysis by Baković (2000) seems to put this assumption in doubt. It is interesting, therefore, that this analysis does not appear to be as empirically adequate as an alternative in which [ATR] is a contrastive feature.

#### 7.4.4.1 The Nez Perce vowel system

The surface vowels of Nez Perce (Aoki 1966, 1970) are shown in (25).

(25) Nez Perce surface vowels (Aoki 1966, 1970)

| | | | |
|---|---|---|---|
| i | | | u |
| | | | ɔ |
| | æ | ɑ | |

Nez Perce has dominant-recessive ATR harmony (B. L. Hall and Hall 1980). All vowels in a word, apart from /i/, must agree with respect to [ATR], and the

20 This section is based on Mackenzie (2002) and Mackenzie and Dresher (2004).

value [−ATR] is dominant. That is, a [−ATR] specification anywhere in the word causes all [+ATR] vowels in the word to become [−ATR]. The vowel /æ/ alternates with /ɑ/ (26) and /u/ alternates with /ɔ/ (27).

(26) ATR harmony: /æ/ alternates with /ɑ/

| | *Underlying* | *Surface* | *Gloss* |
|---|---|---|---|
| a. | /næʔ-mæq/ | næʔmæχ | ‘my paternal uncle’ |
| b. | /næʔ-tɔt/ | nɑʔtɔt | ‘my father’ |
| c. | /mæq-æʔ/ | mæqæʔ | ‘uncle VOC’ |
| d. | /tɔt-æʔ/ | tɔːtɑʔ | ‘father VOC’ |
| e. | /cæqæt/ | cæːqæt | ‘raspberry’ |
| f. | /cæqæt-ɑyn/ | cɑqɑːtɑyn | ‘for a raspberry’ |

(27) ATR harmony: /u/ alternates with /ɔ/

| | *Underlying* | *Surface* | *Gloss* |
|---|---|---|---|
| a. | /tæwæː-puː/ | tæwæːpuː | ‘the people of Orofino, Idaho’ |
| b. | /sɔːyɑː-puː/ | sɔːyɑːpɔː | ‘the white people’ |
| c. | /tuʔuynu/ | tuʔuynu | ‘tail’ |
| d. | /tuʔuynu-ʔɑyn/ | tɔʔɔynɔʔɑyn | ‘for the tail, crupper’ |

As illustrated in (28), the vowel /i/ sometimes patterns with [−ATR] vowels (28a, b), and other times with [+ATR] vowels (28c, d), though it is phonetically [+ATR].

(28) Dual patterning of /i/

| | *Underlying* | *Surface* | *Gloss* |
|---|---|---|---|
| a. | /næʔ-ciːc/ | nɑʔciːc | ‘my paternal aunt’ |
| b. | /ciːc-æʔ/ | ciːcɑ | ‘paternal aunt VOC’ |
| c. | /næʔ-iːc/ | næʔiːc | ‘my mother’ |
| d. | /ʔiːc-æʔ/ | ʔiːcæʔ | ‘mother VOC’ |

Following Jacobsen (1968), Rigsby and Silverstein (1969), Zwicky (1971) and B. L. Hall and Hall (1980), Mackenzie (2002) assumes that surface [i] represents a merger of /i/ and a [−ATR] vowel that can be represented as /ɛ/. In (28a, b) the underlying stem vowel is [−ATR] /ɛ/ and in (28c, d) it is [+ATR] /i/.[21] Thus, every vowel has a counterpart that contrasts with it in the feature [ATR].

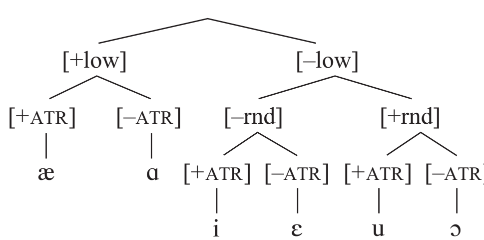
21 In its dual behaviour, Nez Perce /i/ is quite different from Classical Manchu /i/. It is more like Classical Manchu /u/, which represents the surface merger of two underlying vowels when not following a velar or uvular consonant.

(29) Nez Perce underlying vowels

| | | |
|---|---|---|
| i | [+ATR] | u |
| ɛ | [−ATR] | ɔ |
| [+ATR] | | [−ATR] |
| æ | | ɑ |

By any definition, [ATR] would appear to be a contrastive feature in the underlying vowel system of Nez Perce. What are the other contrastive features? Abstracting away from [ATR], we have a classic three-vowel system, which we can designate /I, A, U/. In such systems it is usual to have a height feature, either [low] or [high], and a place feature, either [back] or [round].[22] The feature [low] is a better choice than [high] because the non-low [ATR] pairs are not strictly [+high], whereas the low pair are both [+low]. Following Jakobson and Halle's (1956) assumption that a contrast between high and low sonority is, preferably, ordered before one based on place (but see Ghini 2001b for a different view), let us order [low] as the first feature. For the second feature, either [round] or [back] are possible; for concreteness, we will pick [round]. This contrast is relevant only among the non-low vowels.[23] Because of the symmetry of the system, it does not matter very much where [ATR] is ordered. For concreteness, we will assume it is ordered third. We thus arrive at the contrastive hierarchy illustrated in (30).

(30) Nez Perce: [low] > [round] > [ATR] (Mackenzie 2002)




22 The feature names are chosen to facilitate comparison with Baković's analysis.
23 If one knew nothing about the phonological patterning of Nez Perce and looked only at the underlying vowel system as pictured in (29), one might think it could be analysed the way Jakobson (1962b [1931]) analysed Standard Slovak (see section 1.1), as three pairs of vowels arrayed into three height classes where each pair is distinguished on the front/back dimension. Such an analysis for Nez Perce totally fails as a basis for capturing the facts of vowel harmony.

### 7.4.4.2 The analysis of Baković (2000)

An OT analysis of the Nez Perce vowel system is given by Baković (2000). His analysis has some properties in common with Mackenzie's, namely, a hierarchy of featural faithfulness constraints, and constraints to exclude certain combinations of features. However, he arrives at quite different results. Baković arrives at the ranking shown in (31). He proposes that these faithfulness constraints and co-occurrence restrictions are sufficient to exclude non-existent vowels and to ensure that vowels present in the inventory will surface faithfully.[24]

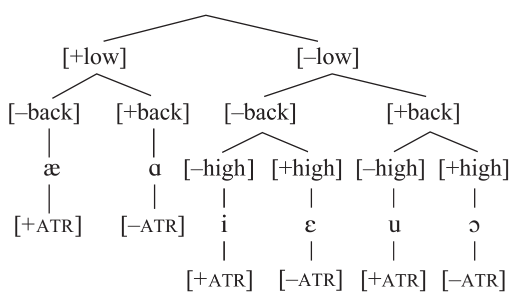
(31) Constraint ranking for Nez Perce (Baković 2000)
*[+back, +ATR] & IO-Ident [ATR], IO-Ident [low], *[−back, −ATR] ≫ IO-Ident [back] ≫ *[−high, +ATR], *[+high, −ATR] ≫ IO-Ident [high] ≫ *[+back, +ATR] ≫ *[−low, −ATR] ≫ IO-Ident [ATR]

Looking only at the faithfulness constraints, we find the hierarchy in (32).

(32) Ranking of faithfulness constraints (Baković 2000)
IO-Ident [low] ≫ IO-Ident [back] ≫ IO-Ident [high] ≫ IO-Ident [ATR]

This constraint hierarchy translates into an ill-formed contrastive hierarchy (33). Features written under the phonemes are redundant.

(33) Contrastive hierarchy based on (32)




The feature [ATR] is phonologically redundant in this hierarchy, though it is the active feature in vowel harmony. It is redundant in the [−low] vowels because of the presence of [high], which does not appear in the contrastive

24 *[+back, +ATR] & IO-Ident [ATR] is a conjoined constraint. A form violates it only if it contravenes both constituent constraints. Thus, the constraint against a vowel that is [+back, +ATR] is ranked fairly low to allow [u] to surface. The individual constraint IO-Ident [ATR] is also ranked low, allowing input vowels to surface with a different value for [ATR], if so compelled by higher-ranking constraints. But if an input vowel is [−ATR], a candidate that is [+back, +ATR] will violate the high-ranking conjoined constraint. Thus, a hypothetical [−ATR] input vowel /ʊ/ may not surface as [u], in this analysis.

hierarchy we arrived at earlier; in the [+low] vowels, it is redundant because it is ordered below [back]. How did Baković (2000) arrive at this feature ranking?

Starting from the assumption that inputs are not restricted to language-specific inventories (richness of the base, Prince and Smolensky 2004), Baković introduces constraints to derive the surface inventory. For example, Nez Perce has no vowel [o], that is, a vowel with the features [−low, −high, +round, +back, +ATR]. Baković (2000: 245) proposes that an input vowel with these features will surface as [ɔ]. To ensure this result, a high ranking of faithfulness to [high] is required, as shown in (34).

(34) Role of IO-IDENT [high] (Baković 2000)

| Input /o/ | *[–high, +ATR] | IO-IDENT [high] | IO-IDENT [ATR] |
|---|---|---|---|
| a. o | *! | | |
| b. u | | *! | |
| c. ☞ ɔ | | | * |

However, Baković adduces no evidence that an input /o/ does in fact surface as [ɔ] and not as [u], or, for that matter, as [i] or [æ]. Therefore, the relatively high ranking of this constraint has no real motivation. Mackenzie's analysis also excludes illicit vowels, though with different results from those proposed by Baković. The contrastive feature hierarchy in (30) translates into the constraint ranking in (35). This ranking also prevents an input /o/ from surfacing as [o], as shown in (36).

(35) Nez Perce constraint hierarchy based on (30)
IO-IDENT [low] ≫ *[round, +low] ≫ IO-IDENT [round] ≫ IO-IDENT [ATR] ≫ *[F]

(36) Evaluation of /o/ with low-ranking IO-IDENT [high]

| Input /o/ = [–low, –hi, +rnd, +ATR] | IDENT [low] | *[round, +low] | IDENT [round] | IDENT [ATR] | *[F] |
|---|---|---|---|---|---|
| a. o = [–low, –hi, +rnd, +ATR] | | | | | ****! |
| b. ☞ u = [–low, +rnd, +ATR] | | | | | *** |
| c. ɔ = [–low, +rnd, –ATR] | | | | *! | *** |
| d. i = [–low, –rnd, +ATR] | | | *! | | *** |

Recall that, unlike Baković, I am assuming that the output of the constraints corresponding to the contrastive hierarchy is a segment specified only for contrastive features. Thus, an input /o/, that is, a vowel specified as [−low, −high, +round, +ATR], yields the winning output [−low, +round, +ATR], which surfaces as [u] in Nez Perce.[25] Put differently, an input /o/ is not contrastively distinct from /u/. In this case, there are two sources that both favour a high vowel as the phonetic specification of [−low, +round, +ATR]: in addition to the usual preference for /I, A, U/ over /E, A, O/, [+ATR] favours [+high], as discussed in connection with Manchu /i/.

Similarly, Baković (2000: 246) wishes to ensure that an input /e/ surfaces as [i]. In his analysis, faithfulness to [back] plays a prominent role in preventing /e/ from surfacing as *[ɔ] (37). Again, there are many other ways of excluding this vowel, and we have no empirical evidence to favour one over another. Another way is shown in (38).

(37) Role of IO-Ident [back] (adapted from Baković 2000)

| Input /e/ | Ident [low] | *[–bk, –ATR] | Ident [back] | *[–hi, +ATR] | Ident [high] | Ident [ATR] |
|---|---|---|---|---|---|---|
| a. e | | | | *! | | |
| b. ☞ i | | | | | * | |
| c. ɛ | | *! | | | | * |
| d. ɔ | | | *! | | | * |
| e. æ | *! | | | * | | |

(38) Evaluation of /e/ without IO-Ident [back]

| Input /e/ = [–low, –hi, –bk, –rnd, +ATR] | Ident [low] | *[round, +low] | Ident [round] | Ident [ATR] | *[F] |
|---|---|---|---|---|---|
| a. e = [–low, –hi, –bk, –rnd, +ATR] | | | | | ****!* |
| b. ☞ i = [–low, –rnd, +ATR] | | | | | *** |
| c. ɛ = [–low, –rnd, –ATR] | | | | *! | *** |
| d. ɔ = [–low, +rnd, –ATR] | | | *! | * | *** |
| e. æ = [+low, +ATR] | *! | | * | | ** |

25 I omit the feature [back], because it would only incur an extra violation of *[F], and thus would not alter the outcome.

Of course, it is ultimately an empirical question what would happen to hypothetical input vowels /o/ or /e/ in Nez Perce. One could seek to find various kinds of evidence that would bear on this question. For example, we could investigate the fate of loanwords with such vowels when adapted into Nez Perce, or devise perception tests to see how speakers label such vowels, and so on. But in the absence of any such evidence, it is impossible to favour any particular result. Therefore, in making predictions about the fate of illicit vowels, we must be guided by our analysis to the extent that it is based on actual empirical evidence.

To conclude, the analysis presented by Baković (2000) appears to require a ranking of faithfulness constraints that is incompatible with any contrastive hierarchy for Nez Perce. Moreover, this analysis does not draw any connection between contrast and phonological activity. Given its low ranking, the feature [ATR] appears to be redundant, though it is the active feature in vowel harmony. If such an analysis were supported by evidence, it would be a counterexample to the Contrastivist Hypothesis. It is significant, therefore, that this ranking is unmotivated by any empirical facts and relies primarily on unsupported assumptions about what non-existent vowels should map to. Moreover, an alternative analysis exists that conforms to the theory being advocated here. In this analysis, the active feature [ATR], together with [low] and [round], is contrastive in the Nez Perce vowel system; there is no evidence that any other vowel features are active in this language.

## 7.5 Metaphony and contrast limited by domain

In chapter 2, section 7.1, I considered the possibility that contrastive features are not assigned globally to phonemes over the whole language, but may be limited by position. In such a procedure, contrasts would be evaluated separately for each distinguished position, or domain. We have not seen this kind of domain-limited contrastive evaluation yet, and in principle a number of conditions must be fulfilled for a language to allow separate contrastive domains.

First, the phonemes that occur in one domain must not have alternants in the other domain. For example, in many languages the same underlying consonant may appear in both coda and onset position. An example is the stem-final consonant in English *write*, which appears in word-final position in the uninflected form, and between vowels when a vowel-initial suffix is added, as in *writing* or *writer*. Presumably, there is a single underlying representation of the morpheme *write*, so it would be contradictory, in English, to assign different contrastive features to the stem-final /t/ when it is word final and when it is word medial.[26]

A second condition that could plausibly be put on a contrastive domain is that it should correspond to a category that has independent existence in the grammar. This condition would rule out arbitrary domains such as, for English, the set of consonants that could precede the sequence *__et* (*pet, vet, debt, set, net, yet, get*, etc.) within a word.

The conditions for having separate contrastive domains for evaluating vowels are met in Romance languages that distinguish between *stem* vowels and *desinential* vowels. Desinential vowels occur in a closed class of suffixes and do not alternate with stem vowels. Moreover, stems and desinences constitute important grammatical categories in such languages. Dyck (1995) and Frigeni (2003) argue that contrastive specifications must be assigned separately to desinential vowels in Romance dialects of Spain and Italy (Dyck) and in Campidanian Sardinian (Frigeni).

The evidence in both cases comes from *metaphony*, a type of vowel harmony in which some high desinential vowels trigger raising of some stressed vowels. It is argued that the best account of metaphony triggers in these dialects requires that we distinguish between contrastive and redundant feature specifications. More particularly, the contrasts must be assigned separately to desinential vowels. As in the cases of harmony discussed above, a vowel can trigger metaphony only if it has the appropriate contrastive feature.

### *7.5.1 Metaphony in Iberian and Italian Romance*

In (39) are examples of metaphony in Pasiego (Montañes), as given by Dyck (1995), adapted from Penny (1969). Centralization/laxing of unstressed vowels is not shown. Desinential /u/ triggers raising of stressed /é/ to [í] and stressed /ó/ to [ú]. Stressed /í/, /ú/, and /á/ are not affected (40).

26 The assumption that morphemes have a unique lexical form is not universally held. In theories that permit multiple lexical representations, the concept of a phonological inventory would have to be rethought along with what constitutes a permissible contrastive domain.

Keeping now to the principle that morphemes have unique underlying forms, it may still be the case that children at early stages of acquisition may not yet relate different forms of morphemes. For example, they may have different lexical representations for the final consonant in *write* and the medial consonant in *writer* (since *writer* is not yet decomposed into separate morphemes, it is not accurate to label the *t* in *writer* as 'stem final' for these learners). It follows that child grammar may have separate sub-inventories and contrastive domains that would not be permitted in the adult grammar.

(39) Pasiego metaphony of /é/ and /ó/ triggered by /u/

| *Unmetaphonized* | *Gloss* | *Metaphonized* | *Gloss* |
|---|---|---|---|
| afilit[é]ros | 'needle-cases' | afilit[í]ru | 'needle-case' |
| g[ó]rdo | 'fat (neuter)' | g[ú]rdu | 'fat (masculine)' |
| ab[jé]rtos | 'open (plural)' | ab[jí]rtu | 'open (plural)' |
| k[wé]rpos | 'bodies' | k[wí]rpu | 'body' |

(40) Pasiego metaphony does not affect /í/, /ú/ and /á/

| *Unmetaphonized* | *Gloss* | *Neutral* | *Gloss* |
|---|---|---|---|
| luz m[í]yos | 'mine (plural)' | il m[í]yu | 'mine (singular)' |
| bj[ú]da | 'widow' | bj[ú]du | 'widower' |
| br[á]θos | 'arms' | br[á]θu | 'arm' |

#### 7.5.1.1 Dyck's Generalization

Dyck (1995), modifying an earlier observation by Penny (1970), formulates the generalization in (41) about Romance metaphony (raising) triggered by desinential vowels.

(41) Generalization about metaphony triggers (Dyck 1995)
Desinential high vowels can trigger metaphony only if they contrast with a mid vowel in the same place.

Note that (41), henceforth Dyck's Generalization, refers to contrasts *only among the desinential vowels*. In every Romance dialect high vowels contrast with mid vowels in stressed syllables; but dialects have different inventories of desinential vowels, ranging from three to five. Because the phonetics of these vowels can vary, I will henceforth represent them schematically as /I ∼ E, A, U ∼ O/ for three-vowel desinential inventories, /I ∼ E, A, O, U/ for four-vowel desinential inventories with a contrast between a high and mid back/labial vowel, and so on.

Dyck's Generalization makes correct predictions about which dialects may exhibit metaphony, and what the possible desinential triggers of metaphony may be in these dialects. First, we expect no raising in dialects with only three desinential vowels /I ∼ E, A, U ∼ O/, because there is no contrast between /I/ and /E/ or /U/ and /O/. For example, no raising is reported in Leonese dialects, where desinences are phonetically [i, a, u] or [e, a, u], depending on the dialect.

In dialects with four desinential vowels /I ∼ E, A, O, U/, the prediction is that raising can be triggered by /U/, not by /I/; in dialects with four desinential vowels /I, E, A, O ∼ U/, we predict that raising can be triggered by /I/, not by /U/. Examples of the former type are Central Asturian, North Central Asturian and Montañes dialects of Santander, where /u/ contrasts with /o/, but there is only a marginal, archaic contrast between /i/ and /e/. As expected, raising is triggered by [u], not by [i].

In dialects with five desinential vowels, Dyck's Generalization predicts that both /I/ and /U/ can trigger raising. No Spanish dialects are of this type, but there are Italian dialects, such as Servigliano, that have five desinential vowels and raising triggered by both [i] and [u].

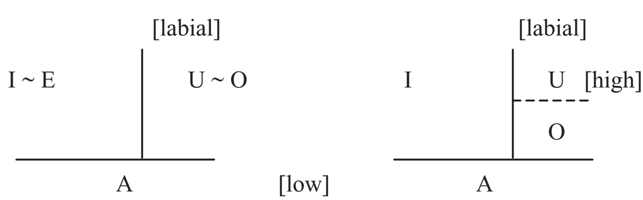
#### 7.5.1.2 Accounting for Dyck's Generalization

In order to account for Dyck's Generalization we must make several assumptions. First, for purposes of evaluating contrasts, vowel inventories must be divided into stem inventories and desinential inventories. Contrasts in each inventory are assessed separately.

Second, we must assume that features in these dialects are ordered [low] > [labial] > [high]. If the first feature is [low], then [high] is not needed in the three-vowel system shown in (42a). The non-low vowels have no contrastive [high] feature to trigger raising, even if they are pronounced as [i] or [u]. In the inventory in (42b), the feature [high] is needed to distinguish between /U/ and /O/, but its scope is limited to the [labial] vowels. Therefore, only /U/ can trigger metaphony, not /I/. These results are strikingly in line with the Contrastivist Hypothesis: only vowels possessing a contrastive feature [high] can trigger metaphony.

(42) Contrastive features in desinential vowels

a. Three desinential vowels  b. Four desinential vowels




#### 7.5.1.3 Phonetics of desinential vowels

Dyck's Generalization by itself does not necessarily demonstrate the correctness of the Contrastivist Hypothesis if the data can be explained in other ways. One possible alternative comes to mind immediately. We might reason that in dialects where a high desinential vowel is in contrast with a mid vowel, the high vowel must be phonetically higher than in dialects where only one vowel covers the high and mid space. It is possible, therefore, that metaphony is triggered by contrastively high desinential vowels not because the phonology is concerned with contrastive specifications, but simply because such vowels are the only ones that are phonetically high enough to trigger metaphony. On this account, Dyck's Generalization is explained by phonetics.

Fortunately, the phonetics of Iberian dialects have been richly documented, and it is simply not the case that noncontrastive high desinential vowels are always lower than contrastively high vowels. In a survey of the phonetic descriptions of these dialects, Dyck (1995) shows that while it is true, as a general tendency, that noncontrastive vowels exhibit greater variability than contrastive vowels, there is also a great deal of variation from dialect to dialect. In the Leonese area, for example, there is no phonological contrast between desinential /i/ and /e/. Nominal desinences vary between [i] and [e], depending on dialect and also context (Dyck 1995: 68–71). If the phonetic hypothesis were correct, we would expect metaphony to depend on the phonetic height of the desinential vowel: in dialects where it is always pronounced [i] in certain lexical items we would expect metaphony in those words; where it varies between [i] and [e], we would expect to find variable metaphony. This is not what is found, however: no synchronic metaphony is reported for the Leonese area.

The conclusion is that a purely phonetic account does not suffice here. Whether a vowel is phonetically high at a given time does not predict the possibility of metaphony. Dyck's Generalization remains true only at the level of contrastive features. Thus, the Contrastivist Hypothesis, together with the proposed contrastive hierarchy, remains the best explanation for this generalization.

### *7.5.2 Metaphony in Campidanian Sardinian*

Frigeni (2003) argues for a domain split in the assignment of contrastive features to vowels in Campidanian Sardinian along the lines of Dyck's analysis. She goes one step further, arguing that the contrastive hierarchy for desinential vowels differs from the one that applies to stem vowels, not just in the number of contrastive features, but also in their ordering.

The surface inventories of stem and desinential vowels are shown in (43).

(43) Surface vowels in Campidanian Sardinian

a. Stem vowels

i u

e o

ɛ ɔ

a

b. Desinential vowels

i u

a

Frigeni argues that at the lexical level there are two fewer stem vowels than in (43a), and two more desinential vowels than in (43b) (cf. Bolognesi 1998: 20–1). She argues that the stem vowels [e] and [o] are derived from /ɛ/ and /ɔ/, respectively, by metaphony, as illustrated in (44).

(44) Campidanian Sardinian metaphony

| a. No metaphony before /-a/ | | b. Metaphony before /-i, -u/ | |
|---|---|---|---|
| pɔ́tːa | 'door F. SG.' | pótːu | 'harbour M. SG.' |
| (a)rːɔ́za | 'rose F. SG.' | drómi | 'sleep INF.' |
| sɛ́rːa | 'hill F. SG.' | ʒéʁu | 'sky M. SG.' |
| fɛ́ʃta | 'party F. SG.' | tésːi | 'weave INF.' |

Since the surface stem vowels *e* and *o* are derivable by metaphony from the corresponding lax vowels, there is no evidence that they are underlying.

In the preceding section we saw that Spanish and Italian dialects with three desinential vowels do not have metaphony. The reason, according to Dyck's analysis, is that metaphony is caused by a contrastive feature [high] which is only present if there is a contrast between a high and mid vowel at the same place. The Sardinian system in (43b) appears to contradict this generalization, but the contradiction is only apparent. Frigeni (2003) shows that the surface desinential vowels *i* and *u* each represent the merger of two vowels, one which causes metaphony, and one which does not. She argues that the vowels which do not cause metaphony derive from underlying /e/ and /o/, which merge with /i/ and /u/, respectively. Therefore, the underlying stem and desinential vowel systems are as in (45). Capital letters indicate that we are not committing to any particular features beyond a minimal contrastive set.

(45) Underlying vowels in Campidanian Sardinian (Frigeni 2003)

| a. Stem vowels | | | b. Desinential vowels | | |
|---|---|---|---|---|---|
| I | | U | I | | U |
| E | | O | E | | O |
| | A | | | A | |

Though the two inventories now look identical, Frigeni argues that their contrastive specifications differ. If we continue to assume that the metaphony trigger is a contrastive feature [high], as in the cases in the previous section, we would expect the mid vowels to raise to high vowels *i* and *u*. Second, metaphony here introduces a new contrast between mid vowels, and it is not clear how spreading [high] to a mid vowel unspecified for any other height feature could lead to this result.

To account for the change undergone by the stem vowels, Frigeni (2003) proposes that the spreading feature in Campidanian Sardinian metaphony is [ATR], not [high]. Hence, [ATR] is the contrastive feature distinguishing desinential /I, U/ from /E, O/. But she demonstrates also that the stem vowels could not be characterized in the same way, or else again we should expect metaphonized vowels to surface as *i* and *u*. She proposes, therefore, that the two domains have different contrastive features, as shown in (46). The stem vowels correspond to a contrastive hierarchy [low] > [labial], [high], and desinential vowels have the contrastive hierarchy [low] > [labial], [ATR].

(46) Underlying contrasts in Campidanian Sardinian (Frigeni 2003)

a. Stem vowels

| | | | | |
|---|---|---|---|---|
| I | | | U | [high] |
| | E | O | | |
| | A | | | [low] |

b. Desinential vowels

| | | | | |
|---|---|---|---|---|
| I | | | U | [ATR] |
| | E | O | | |
| | A | | | [low] |

On this account, metaphony results from the spreading of contrastive [ATR] from a desinential vowel onto a stem vowel. The feature [low] is incompatible with [ATR] in this language, hence /a/ is unaffected by metaphony; the high vowels surface as [ATR] in any case. On the mid vowels, however, the spreading of [ATR] from a desinential vowel has a noticeable effect: /ɛ/ becomes [e] and /ɔ/ becomes [o].

### *7.5.3 Summary*

The generalizations that govern Romance metaphony support the Contrastivist Hypothesis in striking fashion. As predicted, only contrastive features can trigger metaphony. These dialects also exemplify situations where contrast is not evaluated over the entire inventory, but over two different domains; in this case, the desinential vowels are evaluated apart from all the other vowels. These examples also provide evidence that the phonetic realization of a desinential vowel does not predict whether it can be a metaphony trigger. Further, the level at which contrast is required is not at the surface phonetics, but in the underlying lexical representations.

## 7.6 Consonant co-occurrence restrictions

Mackenzie (2005, 2009) argues that the best analysis of many consonant harmony systems requires specifying certain features as contrastive in terms of a feature hierarchy. For then a simple generalization emerges: consonant harmony applies to segments contrastively specified for the harmonic feature.

In Bumo Izon (an Ijoid language of Nigeria), labial and alveolar implosive and plosive stops may not co-occur in a morpheme (Efere 2001). Thus, implosive /ɓ, ɗ/ may not co-occur with plosive /b, d/, though the plosives may freely occur with each other, as may the implosives (47).

(47) Bumo Izon labial and alveolar plosives and implosives (Efere 2001)

| | *Plosives* | | *Implosives* | |
|---|---|---|---|---|
| *Labials* | búbú | 'rub (powder in face)' | ɓʊ́ɓaɪ | 'yesterday' |
| *Alveolars* | | | ɗɔ́ɗɔ́ | 'cold' |
| *Mixed* | bɪ́dɛ́ | 'cloth' | ɗáɓá | 'swamp' |

The velar plosive /ɡ/ and the labiovelar implosive /ɠɓ/, however, may freely occur with members of both the plosive and implosive series, as shown in (48).

(48) Bumo Izon velar plosive and labiovelar implosive (Efere 2001)

| | *Velar plosive /ɡ/* | | *Labiovelar implosive /ɠɓ/* | |
|---|---|---|---|---|
| *With same* | iɡódó | 'padlock' | ɠɓáɓu | 'crack (of a stick breaking)' |
| *With different* | ɗúɡɔ́ | 'to pursue' | ɠɓódaɠɓóda | 'rain (hard)' |
| | ɓúɡí | 'to wring (hand)' | | |

Why are /ɡ/ and /ɠɓ/ exempt from harmony? Consider the inventory of oral stops in this language, shown in (49).

(49) Bumo Izon oral stops (Mackenzie 2005: 174, based on Efere 2001)

| | | labial | alveolar | velar | labiovelar |
|---|---|---|---|---|---|
| plosive | voiceless | p | t | k | kp |
| | voiced | b | d | ɡ | |
| implosive | | ɓ | ɗ | | ɠɓ |

Intuitively, the labial and alveolar voiced plosive stops each have an implosive 'partner', whereas the velar and labiovelar voiced stops have no counterparts. Building on Hansson's (2001) observation that contrast seems to play an important role in accounting for these facts, Mackenzie (2005, 2009) presents an analysis in terms of the contrastive hierarchy.

Assuming that the relevant laryngeal feature is [glottalic], Mackenzie (2005) proposes that the contrastive hierarchy for Bumo Izon is: place features > [voiced] > [glottalic]. That is, the consonants are first distinguished by place, in terms of the place categories shown in (49). Within each place, they are then distinguished by [voiced].[27] Now [glottalic] is needed only to distinguish the labials and alveolars. The contrastive features assigned to the voiced stops are

27 Note that this hierarchy differs from what is suggested by the table in (49), where [voiced] appears to take narrower scope than [glottalic]. Such an ordering would assign contrastive [glottalic] features to the labiovelar stops, wrongly predicting that they participate in harmony.

shown in (50). The phonemes that participate in implosive harmony are exactly the ones that are contrastively specified for the harmonizing feature, [glottalic].

(50) Bumo Izon voiced stops: contrastive features (Mackenzie 2005)

| | b | ɓ | d | ɗ | g | ɠɓ |
|---|---|---|---|---|---|---|
| place | lab | lab | alv | alv | vel | labvel |
| voiced | + | + | + | + | + | + |
| glottalic | − | + | − | + | | |

## 7.7 Loanword adaptation as evidence of phonological organization

Loan phonology has been viewed as a source of evidence bearing on the nature of the grammar of the borrowing language at least since Jakobson (1962b [1931]), and, in the framework of generative phonology, at least since Hyman (1970a, b, 1973). Many basic issues in loan phonology remain controversial. Some have argued that the input to loan phonology is analysed in terms of the phonemes of the lending language (Paradis 1988; LaCharité and Paradis 1997; Jacobs and Gussenhoven 2000; Paradis and Prunet 2000). Paradis and her collaborators, for example, assume that speakers responsible for borrowing are bilingual, and familiar with the grammar of the lending language. Others have assumed that the input to loan phonology is phonetic (Silverman 1992; Yip 1993; Kenstowicz 2003; Steriade 2009). It appears that both views may be correct depending on the social context in which borrowing takes place (Kiparsky 1973: section 3.2; Heffernan 2005, 2007).

There is much evidence that the sound structure of one's native language affects one's perception of foreign sounds (Hancin-Bhatt 1994; Best 1995; Flege 1995; Dupoux *et al.* 1999; Brown 2000). In recent years, some studies have argued that noncontrastive features also play an important role in the adaptation of sounds (Brannen 2002; Pater 2003; see Kang 2007 for discussion of this and related issues). However, as with other aspects of phonology, much discussion of contrastive and redundant features in loanword phonology suffers from the lack of a satisfactory account of which features actually are contrastive.

Turning to our main theme, I will focus on the relationship between loan phonology and the contrastive hierarchy of a language. In chapter 6, section 6, we considered abstractly how the contrastive hierarchy might be brought to bear on loan phonology. In section 7.7.1 I review some early proposals by Jakobson, and section 7.7.2 draws on a study by Herd (2005) that argues for the importance of the contrastive hierarchy in accounting for Polynesian loan phonology.

### *7.7.1 Loanword adaptation and the contrastive hierarchy*

We have seen that Jakobson (1962b [1931]) and Jakobson and Lotz (1949) appealed to how native speakers adapt foreign sounds as evidence that the native language uses a particular set of contrastive features. Jakobson (1962b [1931]) cites the alleged relative ease with which native Slovak and Russian speakers adapt front rounded vowels from French or German, in comparison with the greater difficulty Czech speakers have with such sounds, as evidence that the backness and rounding features are dissociated in the former two languages but not in Czech. Presumably, the independence of these features in Slovak and Russian phonology facilitates their combination in novel ways.

Jakobson and Lotz (1949) argue that the difference between velar and palatal place is irrelevant in French; in their analysis, the palatals /ʃ, ʒ/ and velars /k, ɡ/ both have the place feature [+saturation]. In support of this proposal they cite the frequent adaptation of the English velar nasal /ŋ/ as the palatal /ɲ/ in French. On this view, foreign sounds are filtered through the contrastive features of the native language. Though Jakobson and Lotz do not elaborate on how this might work, we can adapt the 'decision tree' model proposed by Jakobson, Fant and Halle (1952) for identifying phonemes in one's native language as one way of instantiating this idea. Thus, a French speaker hearing or attempting to produce English [ŋ] could proceed down through the French contrastive feature hierarchy, chapter 3's (28) in the proposal of Jakobson and Lotz, making a series of binary decisions: going top down, [ŋ] is [−vocalic], [+nasality] and [+saturation]. At this point there are no further contrastive features to be assigned, and the English sound [ŋ] is identified with the French phoneme /ɲ/.[28]

### *7.7.2 Loanword adaptation in Polynesian languages (Herd 2005)*

Herd (2005) studies patterns of adaptation of English words into a number of Polynesian languages. These languages have impoverished consonantal inventories, so many substitutions can be observed. Herd argues that the adaptation patterns provide evidence for the influence of the contrastive hierarchies of the

28 In this case, we could question the strength of the argument by asking what other French phoneme English [ŋ] could be identified with. In the analysis of Martinet (1964), /ɲ/ is assigned a [palatal] place, and the velars /k, g/ are [dorso-velar]. The combination of [dorso-velar, +nasal] does not exist in native Standard French, and Martinet's analysis does not suggest what strategy would be employed by a French speaker in realizing this sound. If the place feature were considered to be contrastively more important, we might expect it to override the nasal feature, incorrectly yielding /g/ as the substitute for [ŋ]. But it is not clear Martinet's analysis would be committed to this approach.

borrowing languages *à la* Jakobson and Lotz. He argues further that phonetic similarity is not sufficient to account for these patterns. Of the many cases he discusses, I will briefly review the adaptation of coronal fricatives into two Eastern Polynesian languages, Hawaiian and New Zealand Māori.

#### 7.7.2.1 Hawaiian

Hawaiian has a famously small consonantal inventory (51).

(51) Hawaiian Consonantal Inventory

| | | | |
|---|---|---|---|
| p | | k | ʔ |
| | | | h |
| m | n | | |
| w | l | | |

All English coronal obstruents are borrowed into Hawaiian as /k/, including [s], [z] and [ʃ] (52). Note that these segments are not adapted as /h/, which is also a plausible candidate from a phonetic point of view.

(52) Hawaiian adaptation of English coronal fricatives (Herd 2005)

| | | | |
|---|---|---|---|
| a. [s] → /k/ | lettuce → /lekuke/ | soap | → /kope/ |
| b. [z] → /k/ | dozen → /kaakini/ | | |
| c. [ʃ] → /k/ | brush → /palaki/ | machine | → /mikini/ |

#### 7.7.2.2 NZ Māori

NZ Māori has both /k/ and /h/, as well as /t/, though it lacks a phonemic glottal stop (53). In this language, English [s], [z] and [ʃ] are borrowed as /h/, as shown in (54). This is surprising, given that /k/ is available, as in Hawaiian.

(53) NZ Māori Consonantal Inventory

| | | | |
|---|---|---|---|
| p | t | k | |
| f | | | h |
| m | n | ŋ | |
| w | r | | |

(54) NZ Māori adaptation of English coronal fricatives (Herd 2005)

| | | | |
|---|---|---|---|
| a. [s] → /h/ | glass → /karaahe/ | sardine | → /haarini/ |
| b. [z] → /h/ | weasel → /wiihara/ | rose | → /roohi/ |
| c. [ʃ] → /h/ | brush → /paraihe/ | sheep | → /hipi/ |

If substitutions are made on the basis of similarity, these facts are hard to explain. As Herd (2005) points out, if coronal fricatives are more similar to /k/ than to /h/ in Hawaiian, why are they more similar to /h/ than to /k/ in NZ Māori? The relevant notion of similarity must be somehow influenced by the different inventories of these languages. Herd proposes that different contrastive specifications are operative in each language.

7.7.2.3 Contrastive specifications of Hawaiian and NZ Māori consonants

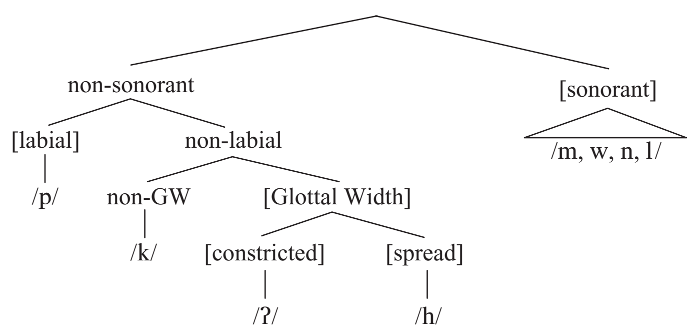
Herd (2005) proposes that the contrastive status of /h/ is different in the two languages. In Hawaiian, /h/ contrasts with /ʔ/. Following Avery and Idsardi (2001), the existence of this contrast activates a laryngeal dimension they call *Glottal Width*. Glottal Width has two values, [constricted] for /ʔ/, and [spread] for /h/.

Herd proposes the feature ordering for Hawaiian shown in (55) (only features relevant to the current discussion are mentioned).

(55) Contrastive hierarchy for Hawaiian (Herd 2005)
[sonorant] > [labial] > Glottal Width ([spread/constricted])

First, [sonorant] distinguishes /m, n, w, l/ from /p, k, ʔ, h/. Next, [labial] splits off /p, m, w/ from the rest. Then laryngeal Glottal Width applies to /ʔ, h/. The result is that /h/ is specified for [spread], /ʔ/ is specified [constricted] and /k/ is the default obstruent (56). Therefore, anything that is not sonorant or labial or laryngeal is adapted to /k/. In particular, [s, z, ʃ] → /k/.

(56) Hawaiian contrastive specifications (Herd 2005)

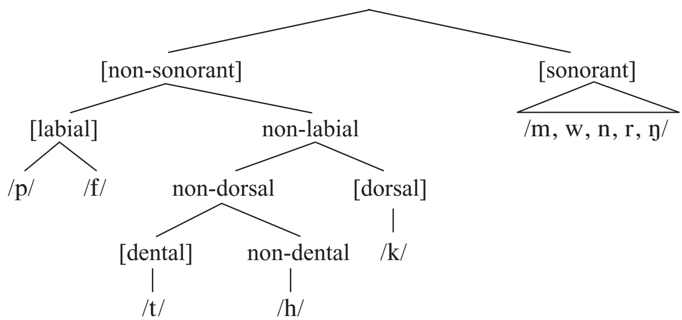



Unlike Hawaiian, NZ Māori has no /ʔ/, so there is no contrast within Glottal Width. Herd (2005) proposes that, lacking such a contrast, [spread] is not accessible as a contrastive feature. This, and the other differences in the inventories of the two languages, result in a different contrastive hierarchy for NZ Māori (57).

(57) Contrastive hierarchy for NZ Māori (Herd 2005)
[sonorant] > [labial] > [dorsal] > [dental]

As in Hawaiian, [sonorant] goes first, splitting off /m, n, ŋ, w, r/, and [labial] follows, applying to /p, f, m, w/. Unlike Hawaiian, [dorsal] is also required, to distinguish /k, ŋ/ from /t, n/. It remains to distinguish /t/ from /h/. Herd proposes to use the feature [dental] to characterize the contrastive property of /t/. This feature accounts for why the interdental fricatives [θ] and [ð] become /t/, not /h/. Thus, in NZ Māori /h/ plays the role of default obstruent, not /k/: /h/ is not sonorant, not labial, not dorsal, and not dental (58). Therefore, [s, z, ʃ] → /h/.

(58) NZ Māori contrastive specifications (Herd 2005)




The different contrastive roles played by /h/ in these languages suggests that they have different 'pattern alignments', in Sapir's terms, despite their very similar phonetic realizations. The differing status of /h/, as well as the presence of /t/ in NZ Māori but not in Hawaiian, also account for the very different contrastive status of /k/ in each language: general default obstruent in Hawaiian, and dorsal obstruent in NZ Māori.

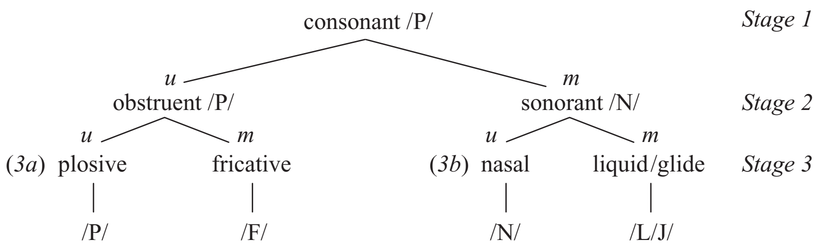
### *7.7.3 Summary*

As mentioned, loan phonology is a diverse phenomenon, and it is unlikely that a single approach can account for all patterns of loanword adaptations. But it suffices for our purposes to show that there exists a class of cases in which loan phonology is sensitive to the contrastive structure of a language; in particular, to the contrastive feature hierarchy. The Polynesian examples discussed above provide a compelling case of this type.

## 7.8 The acquisition of distinctive features and contrasts

Following the pioneering work of Jakobson (1941) and Jakobson and Halle (1956) discussed in chapter 4, section 3, the notion of a contrastive hierarchy has been fruitfully applied in acquisition studies, where it is a natural way of describing developing phonological inventories (Pye, Ingram and List 1987; Ingram 1988, 1989; Levelt 1989; Dinnsen *et al.* 1990; Dinnsen 1992, 1996; see Dresher 1998a for a review). For example, Fikkert describes the development of segment types in onset position in Dutch as in (59).

(59) Development of Dutch onset consonants (Fikkert 1994)




In Stage 1 there are no contrasts. The value of the consonant defaults to the least marked onset, namely an obstruent plosive, designated here as /P/. The first contrast (Stage 2) is between obstruent and sonorant. The former remains the unmarked option (*u*); the sonorant defaults to nasal, /N/. At this point children differ. Some expand the obstruent branch first (Stage 3a), bringing in marked fricatives, /F/, in contrast with plosives. Others (Stage 3b) expand the sonorant branch, introducing marked sonorants, which may be either liquids, /L/, or glides, /J/. Continuing in this way we will eventually have a tree that gives all and only the contrasting features in the language.

While the contrastive hierarchy has been useful in depicting developing inventories as they appear in children's production, experiments on child and infant perception of phonetic contrasts have appeared to support a different view of phonological acquisition. Beginning with Eimas *et al.* (1971), it has been shown that infants can discriminate fine phonetic distinctions in speech sounds, including sounds that are not discriminated in the ambient language (Trehub 1976; Werker *et al.* 1981; Werker and Tees 1984). Thus, whereas adults have difficulty discriminating certain distinctions not used in their native language, infant perception appears to be 'universal'.[29] A series of studies showed that infants 'tune' their phonetic perceptions in accordance with the distribution of sounds in the language they are acquiring, thus eventually losing the ability to discriminate foreign sounds (Werker and Tees 1984; Kuhl *et al.* 1992).

29 There are also studies showing that certain phonetic contrasts are not as well-discriminated by infants as by adult native speakers (Aslin *et al.* 1981; Polka, Colantonio and Sundara 2001; see also Weiss and Maye 2008).

This tuning occurs in the first year, before the learners have acquired a lexicon. These results have led some to conclude that learners acquire the phonemes of their language before they can produce or understand words. For example, Pinker (1994: 264−5) describes the process as follows:

> By six months, [babies] are beginning to lump together the distinct sounds that their language collapses into a single *phoneme*, while continuing to discriminate equivalently distinct ones that their language keeps separate. By ten months . . . they do not distinguish Czech or Inslekampx *phonemes* unless they are Czech or Inslekampx babies. Babies make this transition before they produce or understand words . . . They must be sorting the sounds directly, somehow tuning their speech analysis module to deliver the *phonemes* used in their language. The module can then serve as the front end of the system that learns words and grammar [emphasis added].

On the face of it, it is hard to see how infants can acquire phonemes without knowing if two utterances are the 'same' or 'different' (Bloomfield 1933). It has been argued that learners are particularly attentive to the distribution of sounds, and can draw certain conclusions about whether a cluster of sounds are to be assigned to one category or to more than one, even in the absence of vocabulary or meaning (Maye 2000; Maye, Werker and Gerken 2002; Weiss and Maye 2008). However, distribution can only take one so far. In fact, there is no evidence that infants have acquired *phonemes* by the age of one. The source for Pinker's claims is the following passage by Kuhl *et al.*:

> Infants demonstrate a capacity to learn simply by being exposed to language during the first half year of life, before the time that they have uttered meaningful words. By 6 months of age, linguistic experience has resulted in language-specific *phonetic prototypes* that assist infants in organizing speech sounds into *categories*. They are in place when infants begin to acquire word meanings toward the end of the first year. *Phonetic prototypes* would thus appear to be fundamental perceptual-cognitive building blocks rather than by-products of language acquisition [emphasis added]. (1992: 608)

What Kuhl *et al.* call 'phonetic prototypes' are not equivalent to phonemes; they are *phones*, phonetic variants of phonemes. Infants become sensitive to the phonetic range and distribution of the sounds of their language, so they can tell, for example, that the pronunciation of a Swedish [i] inserted into an English utterance is somehow anomalous. But this is not the same as learning which phones cluster together to form phonemes.

Nevertheless, the fact that infants are able to make fine phonetic discriminations has sometimes been taken as evidence that children's initial phonological representations are accurate and essentially adult-like (cf. Hale and Reiss 1998).

If that is correct, then it must be the case that the appearance that learners are gradually acquiring phonological contrasts is not a reflection of their linguistic competence, but only of production. This theory is bolstered by anecdotes that children are aware of phonemic contrasts that they are unable to produce themselves; a famous example is Neil Smith's son Amahl protesting when his father said *sip* instead of *ship*, even though Amahl himself pronounced both as *sip* (N. V. Smith 1973).

If learners' phonological representations were adult-like from the beginning, we would no longer have evidence that the system of contrasts is learned gradually, nor would we have evidence for a contrastive hierarchy in acquisition. In fact, we would not even have evidence that contrast is important in acquisition, beyond the distribution of surface allophones. However, there is evidence that we cannot draw these conclusions from the above studies.

In sharp contrast to the excellent performance of young children on phonetic discrimination tasks is their inability to utilize fine phonetic differences in word recognition tasks (Stager and Werker 1997; Werker *et al.* 2002; Pater, Stager and Werker 2004). For example, the 14-month-old children studied by Stager and Werker could not distinguish minimally different nonce words such as *bin* and *din* in a word recognition task (when the 'words' were associated with objects), though they could distinguish them in a pure discrimination task. It follows that purely phonetic perception does not translate immediately into phonological representation. The results are consistent with the view that phonological representations do not contain all the details available to phonetic perception (Werker *et al.* 2002; Pater, Stager and Werker 2004; Pater 2004). Fikkert and Levelt (2008) argue that phonological representations are underspecified to begin with, in support of the 'constructionist' or 'emergentist' view of acquisition inspired by production studies. Fikkert (2007) proposes that there is evidence from perception that supports the constructionist interpretation of the production studies.

Putting everything together, we have a picture of a learner going in two directions simultaneously. At the phonetic perceptual level, child learners begin by attending to many potential sources of contrasts, and are more able than adults to discriminate sounds not used in the ambient language (Eimas *et al.* 1971; Werker *et al.* 1981). Acquisition of the native language requires that they 'tune' their perceptual system to the contrasts used in their language, while learning to disregard contrasts that are not used (Werker and Tees 1984; Kuhl *et al.* 1992). Meanwhile, phonological representations are impoverished to begin with (Fikkert 2007). Infants' rich perception of phonetic contrast does not translate into a system of phonological representations (Stager and

Werker 1997). Phonological representations are built into systems of increasing complexity (Rice and Avery 1995), based on the input from phonetic perception together with evidence from the grammar, which itself becomes more complex and removed from the initial percepts (Dresher 1996, 1999).

An important part of phonological learning is the acquisition of the contrastive feature hierarchy. The evidence presented throughout this book suggests that this hierarchy cannot possibly be present from the beginning, because it depends not just on accurate phonetic perception, but on an understanding of various subtle aspects of phonological patterning.

## 7.9 Refining the Contrastivist Hypothesis

Throughout this study I have been assuming that the Contrastivist Hypothesis is as stated in (42) in section 3.7: 'The phonological component of a language L operates only on those features which are necessary to distinguish the phonemes of L from one another' (D. C. Hall 2007: 20). This formulation captures the intuitive idea that the 'phonemic content' or 'pattern alignment' of a phoneme is made up of its contrastive feature specifications. I have cited examples that support the Contrastivist Hypothesis to the extent that they suggest that only contrastive features, as identified by the SDA operating on a contrastive hierarchy, are active in the phonology. The existence of such cases does not, however, exclude the possibility that there are other cases in which demonstrably non-contrastive features are also active in the phonology. Such cases would show that the Contrastivist Hypothesis as stated above is too strong.

In this section I will consider the empirical adequacy of the Contrastivist Hypothesis in this sense. I will conclude that the Contrastivist Hypothesis in its strongest form cannot be maintained. This does not mean that the hypothesis must be abandoned; rather, it can be refined so as to allow for an important class of apparent counterexamples while maintaining the essential spirit of the hypothesis.

### *7.9.1 Is the Contrastivist Hypothesis too weak?*

Before considering if the Contrastivist Hypothesis is too strong, I would like to briefly consider whether it might also be too weak. Saying that a theory is too weak means that it is not sufficiently constrained, and thus is hard or even impossible to falsify.

I addressed this question at the end of chapter 3, where I showed that the Contrastivist Hypothesis is easily falsifiable. It is enough to find examples of more features being phonologically active than are permitted to be contrastive. As the review in the next chapter will show, many theorists assume that such cases are common, to the extent that they allow noncontrastive features to freely figure in the phonology. I conclude, then, that the Contrastivist Hypothesis is not too weak, but is stronger in this regard than many competing approaches.

### *7.9.2 Is the Contrastivist Hypothesis too strong?*

The real question to be addressed is whether the Contrastivist Hypothesis is too strong, and if so, in what ways? When considering counterexamples, it is important to distinguish between apparent counterexamples and real ones.

It is easy enough to find apparent counterexamples to the Contrastivist Hypothesis that turn out not to be real counterexamples to the theory presented here. One reason for this is that many studies make different assumptions about which features are contrastive. Many phonologists continue to arrive at contrastive specifications by something like pairwise comparison, as will become clear in chapter 8. This approach, we have seen, takes logical redundancy as its basic criterion for deciding if a feature specification is contrastive or not. Such theories typically designate too few feature specifications as being contrastive. That is, there will typically be features that the SDA in a certain ordering designates as contrastive that pairwise comparison designates as redundant. If such a feature is active, then we have an apparent violation of the Contrastivist Hypothesis, but one which dissolves when we recognize the feature in question to be contrastive.

For example, the famous unpaired fricatives and affricates of Russian are active in voicing assimilation (see chapter 4, section 6, and section 8.7 below). If pairwise comparison is the procedure for assigning contrastive features, the [−voiced] specifications of these phonemes will be designated as redundant, with the result that a redundant feature triggers assimilation, in violation of the Contrastivist Hypothesis. Adopting the contrastive hierarchy as the procedure for assigning contrasts results in a different conclusion: the features in question are contrastive, and there is no violation of the Contrastivist Hypothesis.

To take another example, Yowlumne labial harmony is triggered by both /o/ and /u/. A number of theories to be discussed in chapter 8 find that the [labial] (or [+round]) specification on /u/ is redundant; this could be because [back] must take precedence over [round], or because /u/ is not sufficiently ‘crowded’, or because [labial] is not the sole feature that distinguishes /u/ from any other phoneme, and so on. In any such theory the crucial harmonic feature is noncontrastive. But in the approach taken here, [labial] is ordered high enough in the feature hierarchy to be contrastive on both /u/ and /o/, and there is no violation of the Contrastivist Hypothesis.[30]

It is only to be expected that there will be many such cases, given the widespread use of pairwise comparison in determinations of which features are contrastive. Therefore, many apparent violations of the Contrastivist Hypothesis can be resolved with a different, arguably more empirically adequate, assignment of contrastive feature specifications.

Another source of uncertainty concerns the dividing point between the phonological component, in which only contrastive features are computed, and the postlexical or phonetic components where this limitation does not obtain. If a post-phonological rule that refers to redundant features is incorrectly assigned to the phonological component, we will create an apparent counterexample to the Contrastivist Hypothesis that will disappear once the rule is reassigned to its correct component.

That said, not all counterexamples to the Contrastivist Hypothesis can be resolved in these ways, and we are left with real counterexamples that have to be accounted for. D. C. Hall (2007) presents one class of cases of this kind, and proposes in response a slight modification of the Contrastivist Hypothesis.

### *7.9.3 'Prophylactic' features (D. C. Hall 2007)*

Yowlumne Yokuts provides a real counterexample to the Contrastivist Hypothesis. We have seen that the underlying vowel system of Yowlumne is specified by two contrastive features, repeated here in more detail as (60).

(60) Yowlumne underlying vowels

| [–round] | [+round] | |
|---|---|---|
| i iː | u uː | [+high] |
| a aː | o oː | [–high] |

In lexical (underlying) forms, Yowlumne has a symmetrical vowel system where each short vowel has a long counterpart. Underlying long high vowels, however, are not pronounced as such, but are lowered. The vowel /uː/ lowers to /oː/, as expected, but lowered /iː/ comes out as [eː], not as [aː]. Inspection of (60) reveals that the allophone [eː] cannot be accommodated with the two features [high] and [round]. A third feature is required to keep [eː] distinct from

30 Yowlumne does pose a real problem, however, which is discussed in the next section.

[aː], and whatever this feature is, it cannot be contrastive. Since the lowering rule feeds further phonological rules, such as shortening (see Kenstowicz and Kisseberth 1977 for a detailed exposition), it is unlikely that it is simply a late phonetic rule. This, then, is a case where a noncontrastive feature is needed in the phonology.

D. C. Hall (2007, 2008) proposes that the noncontrastive feature [+low] must be attributed to /aː/.[31] When /iː/ lowers, it loses its specification [+high], but does not take on [+low]. Thus, it remains distinct from /aː/. Hall observes that the function of the redundant feature [low] is purely passive: it serves only to distinguish segments that would otherwise be neutralized. He calls such features *prophylactic*, defined as in (61).

(61) Prophylactic features (D. C. Hall 2007: 87–8)
A prophylactic feature is a redundant feature that is crucially present in the representation of a segment before the phonological computation begins, but which is invisible to all phonological rules.

Hall discusses several such examples. To cite one more, Czech /t/ and /ř/ (IPA r̝) are distinguished only by the feature [laryngeal], in the analysis of Hall (2007). Devoicing, on this account, is effected by the addition of [laryngeal]. However, when /ř/ devoices it does not merge with /t/, but appears as voiceless [ř̥], an allophone that does not exist as a distinct phoneme in Czech. To prevent a merger with /t/, Hall proposes that /ř/ bears the prophylactic feature [vibrant]. Like Yowlumne [low], this feature does not figure in the phonological computation: it does not trigger rules, and it is not referred to by rules. However, its presence prevents the merger of two phonemes.

Positing prophylactic features represents a minimal retreat from the Contrastivist Hypothesis. It remains to be specified under what conditions such features typically arise, and whether other types of counterexamples must be recognized. In the meantime, the range of cases where the Contrastivist Hypothesis is upheld and contributes to illuminating analyses suggests that it is well worth maintaining and refining as a basic principle of phonological patterning.

31 Hall (2007, 2008) adopts privative features [high], [low] and [peripheral] (for [round]). For ease of exposition I will continue to use binary features. Hall observes that the presence of [low] on /a/ predicts that it should remain a low vowel when it is rounded to /o/. He argues that this is indeed the case, and that the vowel /o/ is transcribed by Newman (1944: 19) as ɔ, ‘as in German *voll* and English *law*’.

## 7.10 Summary

In this chapter I have presented a series of cases that support the Contrastivist Hypothesis as a theory of phonology, and the contrastive hierarchy as a theory of phonological contrast. I have proposed that MCS incorporates the leading ideas of chapter 3 in a contemporary context. I also showed that feature ordering is an inescapable part of phonology, and that much phonological theory and practice incorporates, often tacitly, various aspects of the theory defended here. In some sense, then, this theory makes explicit what has been implicit in phonological thinking for a long time.

The cases discussed are drawn from different domains of phonology: vowel and consonant harmony, loanword adaptation, and acquisition. I have argued that the Contrastivist Hypothesis and the contrastive hierarchy are robustly supported in all these domains, and contribute to a comprehensive and unified account of phonological theory and development.

Of course, many contemporary approaches to phonology do not share the principles defended here, to a lesser or greater extent, and it is to these that I turn in the next chapter.